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

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

El Panul – EcoMethane Landfill Gas to Energy Project
Document Version Number 1
Date completed 19/09/2006

A.2. Description of the project activity:

The El Panul – EcoMethane Landfill Gas to Energy Project (hereafter, the "Project") developed by Biogas Technology Ltd (hereafter referred to as the "Project Developer") is a landfill gas (LFG) collection and utilisation project in the city of Coquimbo, in Chile, hereafter referred to as the "Host Country". The project will have an electricity component with maximum installed capacity reaching 2.3 MW.

The "El Panul" landfill opened in 1981 and nearly 2 million tonnes of solid municipal waste from the cities of Coquimbo, La Serena and Paihuano have been deposited at the site since then. The landfill consists in two main areas, a closed dumpsite and an engineered sanitary landfill which recently started its operation. The older segment of the site started as an open dump, operated later as a controlled dumpsite and finally closed by the end of 2005. The new sanitary landfill area started operations in 2006, currently receiving 400 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 vent system to partially collect and flare the landfill gas.

The objective of the project is to replace the existing ineffective passive venting system by an active gas collection system in order to utilise the LFG of this landfill, thus minimising gaseous emissions and improving the overall landfill operation. This will involve investing in a highly efficient gas collection system, flaring equipment and once the project secures a power purchase contract, a modular electricity generation plant. The generators will combust the methane in the LFG to produce electricity for export to the grid. Excess LFG, and all gas collected during periods when electricity is not produced, will be flared.

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. 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) and the ENER*G Group PLC (ENER*G) for the financing, constructing and operation of LFG projects worldwide, and with EcoSecurities Ltd (EcoSecurities) for the development of these projects under the Clean Development Mechanism of the Kyoto Protocol. For their part, Biogas and ENER*G (sister companies under the same ownership) have more than 20 years experience designing, installing and operating LFG collection and utilisation systems, and are respected leaders in the field. For example, Biogas has designed, installed and operated LFG collection systems on more than 100 landfills, and ENER*G has more than 90 MW of installed electrical generation capacity. For its part, EcoSecurities is a leading CDM/JI project development company.

The Project will have several positive social and environmental impacts:

- First, 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 the potential for LFG migration, which can infiltrate zones outside of the landfill's boundaries and pose dangers to the surrounding population and structures.

- Second, the destruction of the LFG will improve the local environment by reducing the amount of noxious air pollution arising from the landfill, resulting in a considerable reduction of nuisance caused by the odours and also health risks associated to these emissions.

- Third, the project will provide a model for managing LFG, a key element in improving landfill management practices throughout the Host Country.

- Fourth, the project will act as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity.

- Finally, the project will provide for both short- and long-term employment opportunities for local people. Local contractors and labourers will be required for construction, and long-term staff will be used to operate and maintain the system.

The project is helping 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 contaminations;
- Promotes and diversifies sustainable energy systems;
- Increases employment opportunities in the area where the project is located;
- Uses clean and efficient technologies, and conserves natural resources;
- Acts as a clean technology demonstration project, encouraging development of modern and more efficient generation of electricity energy using landfill gas throughout the Country;
- Improves the overall management practices of the landfill.

A.3. Project participants:

Table: 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 S.A. (private entity)	No

United Kingdom of Great Britain and Northern Ireland	Biogas Technology Ltd	No
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Ltd	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 at the south of Coquimbo in a region named “Altas de Panul”, 3 km easterly of the principal road “Ruta 5 Norte” and 18 km from the city La Serena. The geographical coordinates are 30°01' southern Latitude and 71°21' eastern Longitude. The figures below show a map of the location of the project:

Aerial view of the “El Panul” landfill.

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

According to Annex A of the Kyoto Protocol, this project fits in Sectoral Category 13, Waste Handling and Disposal.

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

Landfill Gas Collection System

The Project Developer has over twenty years of practical experience in the design, installation and operation of LFG collection systems. The project activity involves the installation of state of the art LFG collection technology. This includes:

- Vertical gas wells drilled into the waste to extract the LFG. The gas wells cover the area of the landfill available for gas extraction and are spaced on a site-specific grid to maximise LFG collection.
- A gas collection pipe network which consists of pipes that connect groups of gas wells to the manifolds. The manifolds are connected into a main pipe and then into the main header pipe which delivers the gas to the extraction plant and the flare. The system is modular, so it is relatively easy to extend it on parts of the landfill available for gas extraction in the future.
- Dewatering points at strategic low points of the gas collecting work which allow effective condensate management by returning the condensate back to landfill.
- Blower(s) which draw the gas from the wells through the collection system and deliver it to the flare or gas fuelled internal combustion engine powering electricity generator. The system operates at pressure slightly lower than atmospheric and is optimised to address issues related to pressure losses.
- An impermeable cover material (high density polyethylene membrane or mineral material). For efficient operation of the gas collection system, each landfill cell, where the gas is collected from, must be covered with an appropriate capping material to provide sufficient containment and prevent air ingress into the landfill body.

Installation

The gas collection field installation is closely managed and monitored by experienced project managers from the Project Developer in accordance with proven quality control procedures. Experienced key workers are employed to ensure that the gas collection system is installed correctly, and a large portion of the plant and labour is sourced locally. In addition, a comprehensive installation record is maintained to ensure that any future expansion or repair works can be located quickly and efficiently.

Operation

Project Developer’s trained personnel sets up the gas collection system for optimal long-term operation. Their engineers and technicians are involved in balancing the gas collection system on a regular basis in accordance with the monitoring plan.

Sophisticated portable gas monitoring equipment, fitted with an in-built data logging facility and data retrieval to a PC is used in the day-to-day operation of the system. Collected data are emailed to the UK for review on a daily basis. The Project Developer's senior management personnel provide technical support throughout the project to the local personnel employed on the ground.

Flare Technology

The Project Developer has designed, manufactured and installed skid / base mounted and mobile gas flares for burning LFG for over twenty years. Enclosed stacks provide conditions for high temperature combustion to effectively destruct methane with other combustible LFG components and meet low emission regulations in accordance with latest best practice guidelines (UK Environment Agency: Guidance on Landfill Gas Flaring, 2002 - version 2.1).

The project activity involves the installation of a modular enclosed gas flare consisting of pipe work, valves, blower, stack with proprietary burners, instrumentation and control panel. The main features of the gas flare system are presented below.

- The pipe work connects all the elements of the flare from the main header pipe to the burners via a demister with filter element, isolation and control valves, blower and instrumentation. All the pipe work has flanged or threaded connections and is fully galvanised. The demister element protects the fan from moisture and particulates that flow with the gas from the waste deposit. The pipe work has drainage valves for removal of condensate that may accumulate in it.
- Valves used are manually or automatically operated. They can isolate incoming gas or parts of the pipe work in accordance with operational requirements. They are also used to regulate the flow and pressure of the gas.
- The unit has a flame arrester for safety purposes. The flame arrester(s), which is of the deflagration type, is fitted on the main and pilot delivery lines. The arresters protect the blower and the field pipe work from flashback of the flame from the burners.
- The system includes a centrifugal electrically-powered blower, which is a pressure rising machine that generates suction in the gas collection system and positive pressure (above atmospheric) on the burners. The blower drives the gas from the gas wells into the burners.
- The flare stack is made of circular galvanised steel shroud with ceramic lining that maintains high combustion temperature inside. The dimensions of the stack are designed to guarantee safe and effective destruction of the LFG with minimal environmental impact (low emissions). At the bottom of the stack are a set of manual and automatic louvers that control air supply to the burners in order to maintain optimum combustion parameters. The stack is fitted with an igniter that starts the flame on the burners, with a thermocouple (to measure temperature) and a flame detector.
- At high temperature, burners of proprietary Biogas design ensure full destruction of combustible constituents found in LFG, in accordance with the UK Environment Agency guidelines.
- The unit includes sophisticated instrumentation, as follows:
    - pressure, vacuum and temperature gauges and transmitters fitted onto the pipe work that monitor the parameters of the LFG;
    - flow meter to measure accurately the flow of the gas through the system;

  - gas analyser (methane, carbon dioxide, oxygen) that measure the quality of the gas delivered to the flare, as well as gas flow rates and pressure (among other selected parameters);
  - sampling points for taking gas samples with portable instrumentation for laboratory analysis;
  - an ultraviolet camera fitted to the stack that monitors the presence of the flame;
  - a thermocouple that monitors accurately the temperature of the flame in the stack and feeds back the signal to the automated air louver in order to maintain the temperature within the stack at desired level; and
  - a data logging system that transmits the information via telemetry / satellite to the control centre managed by the Project Developer.

- The control panel houses all of the flare controls, motor starters, alarms and interlocks that ensure safe operation of the flare. The control panel enables:
  - powering the plant and its components;
  - a manual, automated or remote start and the shut down of the flare;
  - automated shutdowns and isolation of the gas supply if the safety devices (e.g. flame detector) indicate unsafe operating conditions;
  - an automatic notification of the alarms and shutdowns to the operator via telemetry;
  - an automated temperature control;
  - a local readout of the flare operating parameters and alarms; and
  - an electrical isolation of the whole plant.

Electricity Generation Technology

As and when the project secures a power purchase agreement that will enable the generation of electricity, a modular reciprocating engine facility will be installed. The Project Developer would develop the electricity generation component of the project activity through its relationship with the ENER*G Group, whose subsidiary ENER*G Natural Power has extensive experience in the design, building, and operation of generators using LFG.

The electricity generation project component will involve the construction of a suitable sized compound (50m x 80m) which will comprise a level surface with concrete bases to support the engine units. The compound will have an electrical earthing blanket constructed below the surface to comply with electrical regulations. There will be an electrical sub-station constructed that will contain all suitable switching gear and metering equipment to facilitate a connection to the national grid network. There will be two small support buildings for offices and a workshop. A series of pipes and ducts will be laid to carry both electrical cabling and gas pipes. There will also be three fully bounded tanks for clean oil, dirty oil and coolant storage. The whole area will be securely fenced.

The packaged generation system consists of an outdoor acoustic containerised generating set comprising an engine/alternator set. The engine units comprise a fully containerised Caterpillar (Cat 3516) 16 cylinder turbo charged gas engine, with a separate control room and housing for its own transformer and switch. These units are designed to be fully mobile. The containers are fully sealed (no floor penetrations) to avoid spreading oil through leaks onto the ground, therefore they can be referred to as environmentally compliant. As the gas production increases or decreases (gas production curve) the containerised engine units can be easily added or taken away to match the gas production. These generators are designed and built by the ENER*G Group in Manchester and the design incorporates the following key features:

- Fully enclosed oil-bounded engine compartment and control room;
- Extended oil sumps to increase oil change intervals and reduce downtime;
- Sealed oil pumping lines to make oil changes faster and safer with no risk of spillage;
- A comprehensive, patented, engine management system designed and built in-house, which allows for remote operation and monitoring and has been proven in over 600 applications;
- Sound proofed engine compartments, typically reducing sound levels to 69 dB(A) at 10m;
- Engine emissions that achieve current pre December 31st 2005 engine emission limits as detailed in "Guidance for Monitoring Landfill Gas Engine Emissions" (UK standards);
- EA Technical Guidance, compliant exhaust stacks with monitoring points and optional access platform (retrofitted on site).

All engine units are fitted with remote monitoring technology which is Internet based and allows engines to be started and stopped remotely as well as monitor engine performance, output, and characteristics. Irrespective of this the generation facility will employ full time staff for operation, routine servicing and repairs.

The technology used in the project activity to collect, flare and utilise the LFG comes from the UK. Equipment will be imported and installed in Chile, representing a transfer of technology.

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

Table: Estimated emission reductions from the project

Year	Annual estimation of emission reductions in tonnes of CO_2e
1	89,892
2	97,694
3	99,916
4	102,215
5	104,591
6	107,044
7	109,575
8	112,183
9	100,137
10	86,590
Total estimated reductions (tonnes of CO_2e)	1,009,838

Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	100,984

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:

For the LFG component, ACM0001 version 4, 28 July 2006 "Consolidated baseline methodology for LFG project activities" will be used.

For the electricity generation component, AMS- I.D version 9, 28 July 2006 "Renewable electricity generation for a grid" based on Appendix B of the simplified modalities and procedures for small-scale CDM project activities will be used.

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

The methodology ACM0001 allows for the development of projects falling under either of 3 options:

a) Landfill projects where the captured gas is simply flared; or
b) Landfill projects that use the gas to produce energy (e.g. electricity/thermal energy), but do not claim emission reductions for displacing or avoiding energy from other sources; or
c) Landfill projects where the captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources.

The Project is based on two complementary activities, as follows:

- The collection and flaring or combustion of LFG, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and
- The generation and supply of electricity to the regional grid, thus displacing a certain amount of fossil fuels used for electricity generation.

The Project therefore fulfils the conditions of option c) (i.e., captured LFG is used to produce electricity and reductions are claimed for displacing electricity generation from other sources), and thus ACM0001 was considered the most appropriate methodology for the Project.

ACM0001 states that in the case of option c), the approved small-scale methodology for renewable electricity generation for a grid can be applied (Type I.D) if the amount of electricity generated is below the threshold for small scale projects (15MW). This category comprises renewable energy generation units that supply electricity to an electricity distribution system that is or would have been supplied by at least one fossil fuel or non-renewable biomass fired generating unit. This is therefore applicable to this project. Furthermore, the project activity is not financially viable without CER revenue. LFG revenues (gas, electricity and/or heat) alone are insufficient to recover project investments and operational costs.

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/used. According to AMS-I.D of small-scale CDM methodology, the project boundary should encompass the physical, geographical site of the renewable generation source.

The following project activities and emission sources are considered within the project boundaries:

Table: Sources and gases included in the project boundary

	Source	Gas	Included?	Justification/Explanation
Baseline	LFG venting and partial flaring	CO_2	No	It is not considered because it is part of the natural carbon cycle.
		CH_4	Yes	Included as main component of LFG.
		N_2O	No	Not applicable
Project Activity	Active LFG capture and flaring	CO_2	No	It is not considered because it is part of the natural carbon cycle.
		CH_4	Yes	Included as main component of LFG.
		N_2O	No	Not applicable
	LFG combustion for power generation	CO_2	No	It is not considered because it is part of the natural carbon cycle.
		CH_4	Yes	Included as main component of LFG.
		N_2O	No	Not applicable

- CH_4 emissions from the un-recovered LFG liberated from the landfill sites. It is estimated that only 65% of LFG generated at the EL Panul landfill will be captured, which means that the remaining 35% will be released as fugitive emissions.

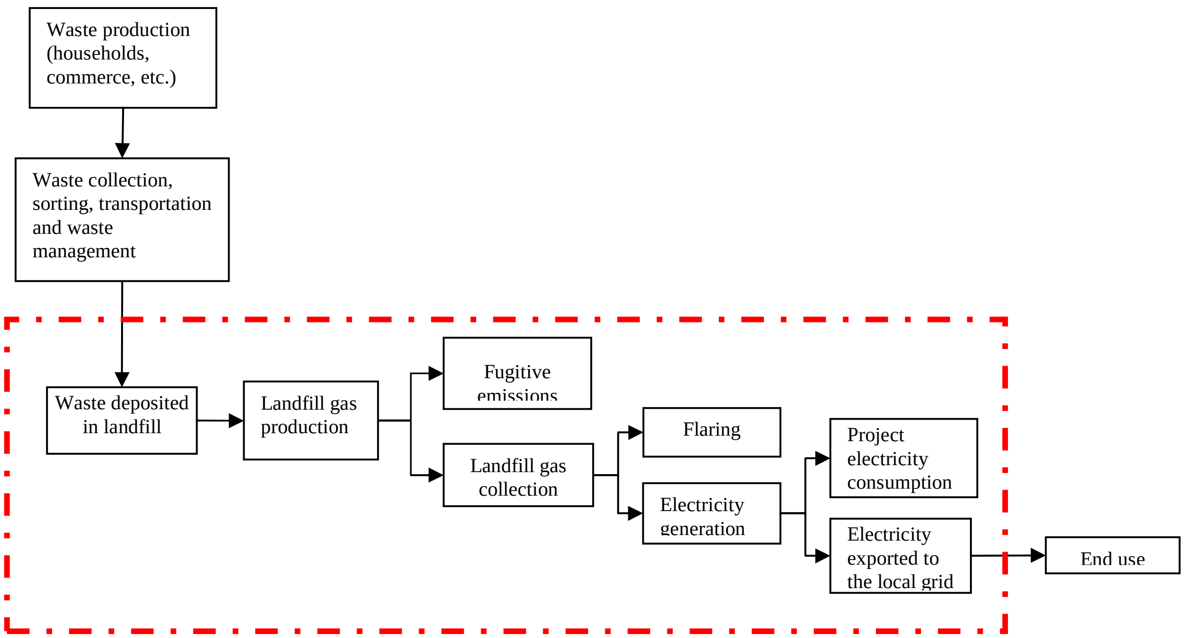
- CO_2 from the combustion of landfill gas in the flares and electricity generator. When combusted, methane is converted into CO_2. As the methane is organic in nature these emissions are not counted as project emissions. The CO_2 released during the combustion process was originally fixed via biomass so that the life cycle CO_2 emissions of LFG are zero. The CO_2 released is carbon neutral in the carbon cycle.

- Electricity required for the operation of the project activity should be accounted for in the project emissions and they need to be monitored. However, as the project activity involves electricity generation and uses electricity generated from LFG, only the net quantity of electricity fed into the grid should be used to account for emission reductions due to displacement of electricity in other power plants.

For the determination of baseline emissions of the electricity generation component of the project, the project boundary will account for the CO_2 emissions from electricity generation in fossil fuel power stations operating in the Project grid system, which will be displaced by the Project activity. The spatial extent of the project boundary is defined as the project site and the plants connected to the grid system to which the project will be connected.

A full flow diagram of the project boundaries is presented in the figure below. The flow diagram comprises all possible elements of the LFG collection systems and the equipment for electricity generation.

Figure: Flow chart of project boundaries (staggered line indicates boundaries)



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

For the baseline determination, the project boundary is the site of the project activity where the gas will be captured and utilised.

As mentioned before, the project activity is based on the two following complementary activities:

- The capture and flaring/combustion of LFG, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and
- The generation and supply of electricity to the regional grid, thus displacing a certain amount of fossil fuels used for electricity generation.

The baseline scenario in this particular case is the partial collection and flaring of the LFG, which occurs at most existing landfills in the Host Country, although some of the landfills in the host country still do not have any type of venting system, but release the LFG uncontrolled to the atmosphere, despite regulations calling for a controlled management of LFG.

There is no incentive to utilise the LFG to produce thermal energy, since the technology does still not exist in the Host country and there is no demand for thermal energy because the project is located in an isolated area.

Given that the results of the financial analysis conducted clearly show that implementation of this type of project is not the economically most attractive course of action, the project is considered to be additional (this is discussed in section B.5 below). In addition, there is no economic incentive or support to develop the project.

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 done using the CDM consolidated Tool for the demonstration and assessment of additionality (version 2) 28 November 2005, which follows the subsequent steps:

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

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

The following alternatives have to be included according to the methodology:

- *The proposed project activity not undertaken as a CDM project activity;*

Alternative 1: The landfill operator would invest in an active LFG capturing system of high effectiveness, as well as a high efficiency flaring system and in LFG power generation equipment (the proposed project activity). The operation would marginally reduce the generation of power from other grid-connected sources. Alternative 1 represents the proposed project activity.

- *All other plausible and credible alternatives to the project activity that deliver outputs and on services (e.g. electricity, heat or cement) with comparable quality, properties and application areas;*

Alternative 2: The landfill operator would invest in an active LFG capturing system of high effectiveness, as well as in a boiler where the captured LFG will be burnt to supply thermal energy to nearby users.

- *If applicable, continuation of the current situation (no project activity or other alternatives undertaken).*

Alternative 3: The landfill operator could continue the current business as usual practice using a simple passive venting system (i.e. partially collect LFG and carry out minimal flaring using an inefficient flaring system). In this case, no power or thermal energy would be generated at the site and the Host Country power system would remain unaffected.

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

Alternative 1, the proposed project activity, complies with all the applicable laws and regulations. Statute N^{o} 19300 "Ley de Bases del Medio Ambiente" from 09 March 1994, and the corresponding landfill regulation "Reglamento de Rellenos Sanitarios", 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 landfill gas control and management but does not clearly define specific requirements regarding amounts of LFG that need to be captured or technologies that shall be used. In addition, this regulation had not come into force at the time of submitting the PDD to validation.

For Alternative 2, there is no existing legal or regulatory requirement which addresses the thermal energy production from LFG at the moment, as the technology is not well known and not applicable for economic reasons. No similar projects using that technique can be found in the Host Country since no potential users could be identified to date.

Alternative 3, to simply continue the current situation, represents one 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 technique which shall be applied to collect, control and monitor the LFG. The regulation notwithstanding, common practice demonstrates that existing landfills in the country do not adequately capture and utilise their LFG, as explained below in Step 4.

The tool for the demonstration and assessment of additionality clearly states that only laws that are enforced need to be considered in the determination of the baseline scenario. Law N^{o} 19300 is not enforced in the waste sector and the corresponding landfill regulation does not move ahead since its year of publication in 2003.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the tool for the demonstration and assessment of additionality, one of three options must be applied for this step: (1) simple cost analysis (where no benefits other than CDM income exist for the project), (2) investment comparison analysis (where comparable alternatives to the project exist) or (3) benchmark analysis.

Sub-step 2b: Option III - Apply benchmark analysis

According to the methodology for determination of additionality, if the alternatives to the CDM project activity do not include investments of comparable scale to the project, then Option (3) must be used. In this case, the most likely alternative to the project is to simply not install flaring and generation equipment at the site, and therefore does not involve investments of a similar scale to the project. Therefore benchmark analysis will be applied.

The likelihood of development of this project, as opposed to the continuation of current activities (i.e. partial collection and combustion of LFG) will be determined by comparing its IRR with the benchmark rates of return available to investors in the Host Country. These rates of return are taken from investment fund indices, provided by MSCI[1]. The rates of return on investment provided by this fund was 14.5% on average over the last 5 years (2001-2006), which represents a significant lower growth rate for emerging markets than typical for Latin America, and therefore can be considered as a moderate benchmark for the performance of investments in the landfill sector in the Host Country.

Sub-step 2c: Calculation and comparison of financial indicators

The Table below shows the financial analysis for the project activity. As shown, the project IRR (without CDM revenue) is -4.7%, lower than the benchmark IRR from the performance of the investment funds in the Host Country.

Table: Financial results of the project (Alternative 1) with and without carbon finance. NPV uses 12% discount rate. The electricity price is assumed to be US$58/MWh, consistent with current prices, which are not expected to change substantially.

	With CDM	**Without CDM**
Net Present Value (US$)	1,046,414	-1,546,482
IRR	20.3%	-4.7%
Discount rate	12%	

Summary of results of project analysis. Details made available to validators.

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted by altering the following parameters:

- Increase in project revenue (price of electricity sold to the grid);
- Reduction in project capital (CAPEX) and running costs (Operational and Maintenance costs).

[1] MSCI provides global equity indices, which, over the last 30+ years, have become the most widely used international equity benchmarks by institutional investors. MSCI constructs global equity benchmark indices that contribute to the investment process by serving as relevant and accurate performance benchmarks and effective research tools, and as the basis for various investment vehicles. http://www.msci.com/overview

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 10%, and assessing what the impact on the project IRR would be (see Table below). As it can be seen, the project IRR remains lower than its alternative even in the case where these parameters change in favour of the project.

Table: Sensitivity analysis

Scenario	% change	IRR (%)	NPV $US
Original		-4.7%	-1,546,482
Increase in project revenue	10%	-1.7%	-1,369,459
Reduction in project costs	10%	-1.6%	-1,238,682

Note: NPV uses 12% discount rate.

In conclusion, the project IRR remains low even in the case where these parameters change in favour of the Project. The IRR is still negative, therefore not feasible for a risky enterprise such as the construction and operation of a landfill gas-to-energy project, and significantly lower than private equity investments with rates of return of 14.5%. Consequently, the Project cannot be considered as financially attractive without CDM revenue.

Step 4. Common Practice Analysis

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

While the Chilean Ministry of Health is still developing a new national legislation for the landfill sector which will include detailed information for LFG management, the current Chilean landfill regulation does neither define how to capture LFG nor give any specifications about amounts of LFG that need to be collected and utilised. Furthermore, it is still not legally binding as it has not been adopted yet. The new landfill legislation is still at a draft stage and it has not been decided yet which percentage of the LFG has to be captured and/or flared.

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 the generated LFG. The table below presents information regarding a representative sample of landfills throughout the Host Country.

As the table below indicates, 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 flaring 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. All projects similar to the proposed project activity are developed under the CDM, and can therefore not be considered to be common practice.

Table: The Project control group

Landfill Name	Location	Waste Deposition Rate (tonnes/day)	Current Status

Lepanto	Santiago de Chile	3,800	System to actively collect and flare the LFG, CDM project activity
El Molle	Valparaíso	500	System to actively collect and flare the LFG, CDM project activity
Coronel	Concepción	525	Passive venting and partial flaring
Empalme	Puerto Montt	500	Passive venting
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	nd	Passive venting and partial flaring

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

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

Step 5. Impact of CDM registration

As shown in Step 2 above, the project is unlikely to move forward without the additional financial support of the CDM. If the developer were able to sell emission reduction credits from the project activity, the additional revenue generated by carbon sales would be sufficient to make the project go ahead (see Table in sub-step 2c above).

B.6 Emission reductions:

B.6.1. Explanation of methodology choices:

The Methodology ACM0001 version 4 is applicable to the proposed project activity, as it is applicable to landfill gas capture project activities where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources[2]; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable

[2] 1 Although in this case no emission reductions are claimed for displacing or avoiding energy from other sources, all possible financial revenues and/or emission leakages shall be taken into account in all the analyses performed.

Sources" version 6, 19 May 2006. If capacity of electricity generated is less than 15MW, small-scale methodology AMS-I.D version 9 can be used. In the case of the project, the electricity generation will be less than 15 MW, therefore AMS-I.D has been chosen.

As mentioned before, the Project is based on two complementary activities, as follows:

- The active collection and controlled flaring/combustion of LFG, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and
- The generation and supply of electricity to the regional grid, thus displacing a certain amount of fossil fuels used for electricity generation.

The Project therefore fulfils the conditions of option c), and thus ACM0001 was considered the most appropriate methodology for the Project.

Project emissions:
The Methodology clearly states that possible CO_2 emissions, resulting from other fuels than the recovered methane, should be accounted for as project emissions. Hence, this has not to be taken into account for the proposed project activity as no other fuels are used within the project boundary. When the project generates electricity, there is a net export of electricity to the grid and the project emissions from its electricity use are deducted from the emission reductions from its electricity generation (thus emission reductions only for the net electricity generated are claimed). In this case the project emissions are zero. The electricity imported for the operation of the project activity will be monitored as stated in the Monitoring Information in Annex 4.

Baseline emissions:
Although the project currently has a LFG collection system, no fossil fuel consumption exists for the baseline emissions because the site only contains a simple passive venting system where no pumping equipment is used.
The baseline emissions reductions due to the partial collection and uncontrolled combustion of the LFG will be taken into account by applying the AF.

Leakage emissions:
No leakage effects need to be accounted under this methodology.

Emission reductions:
According to the Methodology the greenhouse gas emission reductions achieved by the project activity during a given year "y" (ER_y) shall be estimated as follows:

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

As the proposed project activity does not include a thermal component, the following simplified equation will be applied to estimate the emission reductions:

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

As the project electricity consumption is already considered in the formula, in cases when the project is not generating electricity, the EL_y term would be negative and therefore the corresponding project emissions would be deducted from the project's overall emission reductions.

All equations applied to obtain the emission reduction from the project activity are listed in Section B.6.3.

AMS-I.D states that the Operating Margin and the Build Margin for the grid to which the project is connected shall be calculated according to the procedures described in ACM0002.
Thus, ACM0002 version 6, 19 May 2006 was chosen to obtain the resultant grid Carbon Emission Factor. From the four different procedures to calculate the Operating Margin, option d) the average OM was chosen to be the most appropriate for the small scale electricity generation by the project activity.
Option a) the Simple OM is not applicable in the Host Country since must-run generating sources make up more than 50% of grid generation, and options b) and c), the Simple Adjusted OM and the Dispatch Data Analysis could not have been applied as there was not a sufficient amount of data publicly available at the time of completion of the PDD. Even if data for the Dispatch Data analysis was available, the costs of processing the data would not be considered affordable by the project developer.

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

Table: data and parameters that are available at validation

Data / Parameter:	**Carbon Emission Factor ($CEF_{electricity,y}$)**
Data unit:	*tCO2/MW*
Description:	CO_2 emissions intensity of the electricity displaced
Source of data to be used:	Official statistics from CDEC-SIC[3], Chile
Value of data applied for the purpose of calculating expected emission reductions in section B.5	**0.264**
Description of measurement methods and procedures to be applied:	The $CEF_{electricity,y}$ is calculated according to the equations for small scale electricity projects, using AMS-I.D, 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.
QA/QC procedures to be applied:	Not applicable, since CEF is calculated based on official data sources.
Any comment:	

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	Test
Description:	Regulatory requirements relating to landfill gas projects
Source of data to be used:	National legislation and mandatory regulations

[3] Centro de Despacho Económico de Carga – Sistema Interconectado Central; https://www.cdec-sic.cl/estadisticas/acceso_publico.html

Value of data applied for the purpose of calculating expected emission reductions in section B.5	Will be reflected in the AF. Further information can be found in section B.6.3.
Description of measurement methods and procedures to be applied:	The information will be recorded annually, to use it for changes to the adjustment factor (AF) or directly to $MD_{reg,y}$ at renewal of the credit period.
QA/QC procedures to be applied:	Not applicable
Any comment:	

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

The methodology ACM0001 requires that 'Project proponents should provide an *ex-ante* estimate of emission reductions, by projecting the future GHG emissions of the landfill. In doing so, verifiable methods should be used'. In the case of this project, a proprietary model based on the US EPA's first order decay model is used to determine estimated emission reductions *ex-ante*. This *ex-ante* estimate is for illustrative purposes, as emission reductions will be monitored *ex-post*, according to the methodology.

ACM0001 will be applied using option c) of the Consolidated Methodology, where the gas captured is used for electricity generation and emission reductions are claimed for displacing or avoiding energy from other sources. The amount of credits for these sources will be calculated using the Methodology for Small-scale Renewable Energy Projects Type I.D., as the electricity generation component of the project is smaller than 15 MW installed capacity. The data used for the calculation of combined margins is shown in Annex 3 of this document. The main source of data is the Annual Report 2006 from the Load Economic Dispatch Centre – Central Interconnected System (CDEC-SIC)[4]. The defaults used for the calculation of calorific values for fuel types and fuel oxidisation, come from the IPCC GHG Gas Inventory Reference Manual (IPCC 1996) or as clearly marked else wise.

Landfill gas component

The amount of methane destroyed by the project activity is calculated using the following equation, which is simplified in our case since there is no thermal component:

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

Where:

$MD_{project,y}$:	Quantity of methane destroyed by the project activity during a year *y*, in tonnes (tCH_4);
$MD_{flared,y}$:	Quantity of methane destroyed by flaring during a year *y*, in tonnes (tCH_4);
$MD_{electricity,y}$:	Quantity of methane destroyed by generation of electricity during a year *y*, in tonnes (tCH_4).

[4] An organisation defined in General Law of Electrical Services, Decree Law Nº 1, of the year 1982, and established by Supreme Decree Nº 327, of 1997, both of Ministry of Mining. (http://www.cdec-sic.cl/datos/anuario2006/english.html)

The sum of the LFG quantities fed to the flare and/or the power plant will be compared annually with the total LFG captured using the formula below. The lowest value will be adopted as $MD_{project,y}$.

$$MD_{total,y} = LFG_{total,y} * w_{CH4,y} * D_{CH4}$$

Where:

$MD_{total,y}$:	Total quantity of methane captured during a year *y*, in tonnes (tCH_4);
$LFG_{total,y}$:	Total quantity of landfill gas captured during a year *y*, in cubic meters (m^3LFG);
$w_{CH4,y}$:	Average methane fraction of the landfill gas, as measured during a year *y* and expressed as a fraction in cubic meter of methane per cubic meter of landfill gas (m^3CH_4 / m^3LFG);
D_{CH4}:	Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4 / m^3CH_4).

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

$$MD_{flared,y} = LFG_{flared,y} * w_{CH4,y} * D_{CH4} * FE$$

Where:

$MD_{flared,y}$:	Quantity of methane destroyed by flaring during a year *y*, in tonnes (tCH_4);
$LFG_{flared,y}$:	Quantity of landfill gas flared during a year *y*, measured in cubic meters (m^3LFG);
$w_{CH4,y}$:	Average methane fraction of the landfill gas as measured during a year *y* and expressed as a fraction in cubic meter of methane per cubic meter of landfill gas (m^3CH_4 / m^3LFG);
D_{CH4}:	Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4 / m^3CH_4);
FE:	Flare efficiency expressed in the fraction of the methane destroyed (%).

The quantity of LFG flared by the project is estimated using a proprietary model based on the US EPA First Order Decay Model[5], using L_o (methane generation potential) and k (methane generation rate constant) values appropriate for the Host Country and assuming that only 45% of the LFG generated is collected by the gas collection system. The collection efficiency value considers the physical conditions of this landfill as well as the capping material used to cover the waste. In any case, as this projection is merely for illustrational purposes only, the precision of these values are not as significant as the actual emission reductions will be monitored directly. The details of the assumptions of the model are provided in Annex 3.

The table below shows the emission reductions that would take place in the project scenario ($MD_{project}$), using the equations described below.

Table: Emission reductions in the project scenario for the landfill component (amount of methane destroyed).

	Per year (average)	**10 years**
LFG_{flare} (m^3LFG)	13,363,695	133,636,948
CH_4 Concentration (%)	51%	51%

[5] On this model, see US EPA manual "Turning a Liability into an Asset: A Landfill Gas to Energy Handbook for Landfill Owners and Operators" (December 1994).

Density of CH_4 (tCH_4 / m^3CH_4)	0.0007168	0.0007168
Flare Efficiency (%)	99%	99%
$MD_{project}$ = MD_{flared} (tCH_4)	4,821	48,210
$MD_{project}$ = MD_{flared} (tCO_2e)	101,240	1,012,402

The quantity of methane destroyed through combustion in the electricity generation engines is calculated using the following equation:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$$

Where:

$MD_{electricity,y}$:	Quantity of methane destroyed by generation of electricity during a year *y*, in tonnes (tCH_4);
$LFG_{electricity,y}$:	Quantity of landfill gas fed into the electricity generator during a year *y*, in tonnes (tCH_4);
$w_{CH4,y}$:	Average methane fraction of the landfill gas as measured during a year *y*, expressed as a fraction in cubic meter of methane per cubic meter of landfill gas (m^3CH_4 / m^3LFG);
D_{CH4}:	Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4 / m^3CH_4).

The quantity of methane destroyed through the combustion in the electricity generation engines ($MD_{electricity,y}$) would be calculated using the same equation as above, except for not using the adjustment factor related to flare efficiency (FE).

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

$$MD_{reg,y} = MD_{project,y} * AF$$

Where:

$MD_{reg,y}$:	Quantity of methane that would have been destroyed/combusted during a year *y* in the absence of the project activity in tonnes (tCH_4);
$MD_{project,y}$:	Quantity of methane actually destroyed-combusted during a year *y*, in tonnes (tCH_4);
AF:	Adjustment factor in percentage (%).

The adjustment factor AF was set at 5%. This value is justified based on the fact that the regulatory requirements do not indicate any specific amount of gas collection and destruction or utilisation and that in practice, minimal amounts of LFG are actually flared. In addition, currently the landfill operator is passively venting and minimally flaring the collected gas produced in the landfills, primarily for safety purposes.

Due to the closeness of the landfill site to the Pacific Ocean and its relatively high location over sea level, strong winds keep blowing out the manually lit gas wells, which only consist of rusty oil drums embedded in the waste body. Both the strong wind and the low LFG collection and combustion efficiency can not guarantee a LFG destruction over 5% of the LFG generated. Therefore, although the baseline for methane destruction is not quite 0%, the adoption of an adjustment factor of 5% is considered to be conservative for the baseline scenario.

The table below shows the emission reductions that would have taken place in the baseline scenario ($MD_{reg,y}$), using the equation above.

Table: Emission reductions in the baseline scenario for the landfill component (amount of methane destroyed).	**Per year (average)**	**10 years**
MDproject (tCH_4)	4,821	48,210
AF (%)	5%	5%
MD_{reg} (tCH_4)	**241**	**2,410**
MD_{reg} (tCO_2e)	**5,062**	**50,620**

Electricity component

The emission reductions from the electricity component are calculated using the grid emission factor calculated below and an estimation of the net quantity of electricity displaced by the project (ELy) based on the electricity calculation parameters provided in Annex 3.

The greenhouse gas emission reductions achieved by the project activity during a given year *y* (ER_y) are calculated using the simplified equation mentioned earlier in section B.6.1:

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

Where:

ER_y:	is emission reduction during a year *y*, in tonnes of CO_2 equivalents (t CO_2e);
$MD_{project,y}$:	the amount of methane that would have been destroyed/combusted during a year *y*, in tonnes of methane (tCH_4);
$MD_{reg,y}$:	the amount of methane that would have been destroyed/combusted during a year *y* in the absence of the project, in, tonnes of methane (tCH_4);
GWP_{CH4}:	Global Warming Potential value for methane for the first commitment period is 21 t CO_2e / tCH_4;
EL_y:	net quantity of electricity exported during a year *y*, in megawatt hours (MWh);
$CEF_{electricity,y}$:	CO_2 emissions intensity of the electricity displaced during a year *y*, in tCO_2e/MWh, using AMS I.D;

Total electricity used *for* the project will be deducted from the amount of electricity produced *by* the project, thus emission reductions will only be claimed for the *net* electricity supplied to the grid. Net electricity generated by the project is therefore estimated using the following formula:

$$ELy = EL_{EX,LFG} - EL_{IMP}$$

Where:

$EL_{EX,LFG}$:	net quantity of electricity exported during a year *y*, produced using landfill gas, in megawatt hours (MWh);
EL_{IMP}:	net incremental electricity imported, defined as difference of project electricity imports

	less any imports of electricity in the baseline, to meet the project requirements, in MWh.

As the project electricity consumption is already considered in the formula above, in cases when the project is not generating electricity, the El_y term would be negative and therefore the corresponding project emissions would be deducted from the project's overall emission reductions.

The following tables show the emission reductions from the displacement of grid electricity.

Table: Emission reductions from electricity generation

	Per year (average)	**10 years**
$EL_{EX,LFG}$ (MWh)	15,640	156,400
CEF (tCO_2/MWh)	0.264	0.264
Emission reductions from electricity generation (tCO2e)	4,129	41,290

Table: Project emissions due to electricity consumption

	Per year (average)	**10 years**
EL_{IMP} (MWh)	263	2,628
CEF (tCO_2/MWh)	0.264	0.264
Emissions from electricity consumption (tCO_2e)	69	694

Table: Summary of total net emission reductions from the project activity

	Per year (average)	**10 years**
Emission Reductions in Project Scenario – flaring (tCO_2e)	101,240	1,012,402
Emission Reductions in Baseline Scenario – flaring (tCO_2e)	5,062	50,620
Net Emission Reductions – flaring (tCO_2e)	96,178	961,782
Emission Reductions in Project Scenario - electricity generation (tCO_2e)	4,129	41,290
Project Emissions- electricity consumption (tCO_2e)	69	694
Net Emission Reductions – electricity (tCO_2e)	4,060	40,596

Total Net Emission Reductions by the Project Activity (tCO_2e)	**100,238**	**1,002,378**

The $CEF_{electricity,y,}$ for the grid will be calculated according to the equations for small scale electricity projects (Methodology for Small Scale Activities AMS Type 1.D-Renewable Electricity Generation for a Grid). As the Methodology ACM0002 clearly states, that power plant capacity additions registered as CDM project activities should be excluded from the calculations, so they will not be taken into account in the following calculations.

The carbon emission factor ($CEF_{electricity}$) is calculated in 3 steps, as follows:

- STEP 1. Calculate the Operating Margin emission factor **($EF_{OM,y}$)**, based on option (d) Average OM.
  (d) Average OM. The average Operating Margin (OM) emission factor ($EF_{OM,average,y}$) is calculated as the average emission rate of all power plants, using the following equation, but including low-operating cost and must-run power plants.

$$EF_{OM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

Where:

$F_{i,m,y}$	The amount of fuel *i* (in a mass or volume unit) consumed by relevant power plants *m* in year(s) *y*;
$COEF_{i,m}$	The CO_2 emission coefficient of fuel *i* (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power plants *m* and the percent of oxidation of the fuel in year(s) *y*;
$GEN_{m,y}$	The electricity (MWh) delivered to the grid by power plant *m*.

The CO_2 emission coefficient $COEF_{i,m}$ is obtained as

$$COEF_{i,m} = NCV_i \cdot EF_{CO2,i} \cdot OXID_i$$

Where:

NCV_i	Net calorific value (energy content) per mass or volume unit of a fuel *i*;
$EF_{CO2,i}$	CO_2 emission factor per unit of energy of the fuel *i* (tCO_2 / TJ);
$OXID_i$	Oxidation factor of the fuel.

- STEP 2. Calculate the Build Margin emission factor **(*$EF_{BM,y}$*)** as the generation-weighted average emission factor (tCO2/MWh) of a sample of power plants *m*, as follows:

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

Where:

$EF_{BM,y}$	Build Margin Emission Factor in year *y*;
$F_{i,m,y}$	Amount of fuel *i* (in a mass or volume unit) consumed by relevant power plants *m* in year(s) *y*;
$COEF_{i,m}$	CO_2 emission coefficient of fuel *i* (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by the relevant power plants *m* in year(s) *y*;
$GEN_{m,y}$	Electricity delivered to the grid by power plants *m* in year *y*, in MWh.

$EF_{BM,y}$ will be determined *ex-ante*, basing on the most recent information on plants already built in the Host Country at the time of PDD submission.

- STEP 3. Calculate the baseline emission factor $\boldsymbol{EF_y}$ as the weighted average of the Operating Margin emission factor $\mathbf{EF_{OM,y}}$ and the Build Margin emission factor $\boldsymbol{EF_{BM,y}}$ with the following equation:

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh.

The tables below shows a summary of the operating and build margin used for calculating the $\boldsymbol{CEF}_{electricity,y,}$.

Table: Operating Margin of the Chilean Electricity Grid "SIC"

Operating Margin of the Electricity Grid using the "average OM option"	**2003**	**2004**	**2005**
Electricity Generation (GWh)	32,935	36,154	37,807
Carbon Emissions (tCO_2)	7,337,312	9,930,011	8,730,639
Operating Margin (tCO_2 / MWh)	0.223	0.275	0.231
Weighted Average Operating Margin (tCO_2 / MWh)	**0.243**		

Table: Build Margin of the Chilean Electricity Grid "SIC"

Build Margin of the Electricity Grid using the "ex-ante option"	**2005**
Electricity Generation (GWh)	7,570
Carbon Emissions (tCO_2)	2,162,224
Build Margin (tCO_2 / MWh)	**0.286**

Table: Combined Margin of the Chilean Electricity Grid "SIC"

Combined Margin of the Electricity Grid	
Operating Margin (tCO_2 / MWh)	0.243
Build Margin (tCO_2 / MWh)	0.286
Combined Margin (tCO_2 / MWh)	**0.264**

Detailed information of the used data and the calculations made are attached to Annex 3.

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

The Consolidated Methodology for landfill projects uses an equation for calculating the amount of methane destroyed in the baseline scenario, as opposed to the amount of methane emitted in this scenario. We will use the convention established in the consolidated methodology and use this section to describe the amount of methane destroyed in the baseline and project scenario.

Year	**Estimation of project activity emissions reductions (tonnes of CO_2 e)**	**Estimation of baseline emissions reductions (tonnes of CO_2 e)**	**Estimation of leakage (tonnes of CO_2 e)**	**Estimation of overall emission reductions (tonnes of CO_2 e)**
Year 1	94,623	4,731	Not applicable	89,892
Year 2	102,584	4,890	Not applicable	97,694
Year 3	104,923	5,007	Not applicable	99,916
Year 4	107,343	5,128	Not applicable	102,215
Year 5	109,844	5,253	Not applicable	104,591
Year 6	112,426	5,382	Not applicable	107,044
Year 7	115,090	5,515	Not applicable	109,575
Year 8	117,835	5,652	Not applicable	112,183
Year 9	105,155	5,018	Not applicable	100,137
Year 10	91,023	4,433	Not applicable	86,590
Total (tonnes of CO_2e)	**1,060,847**	**51,009**	**Not applicable**	**1,009,838**

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 LFG captured
Source of data to be used:	Project Developer

Value of data applied for the purpose of calculating expected emission reductions in section B.5	13,363,695 (average)
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be < 3%. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	

Data / Parameter:	$\mathbf{LFG_{flared,y}}$
Data unit:	Nm^3
Description:	Amount of LFG flared
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,197,695 (average)
Description of measurement methods and procedures to be applied:	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be < 3%. Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	

Data / Parameter:	$\mathbf{LFG_{electricity,y}}$
Data unit:	Nm^3
Description:	Amount of LFG combusted in power plant
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10,166,000 (average)
Description of measurement methods and procedures to be	Data will be measured continuously with a flow meter by the project developer. The flow meter will be maintained and calibrated regularly in line with the manufacturer's requirements. This will ensure that the accuracy of the measurement instrument is maintained, which can be assumed to be < 3%.

applied:	Data to be aggregated monthly and yearly.
QA/QC procedures to be applied:	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	

Data / Parameter:	**FE**
Data unit:	%
Description:	Flare/combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2)
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	99%
Description of measurement methods and procedures to be applied:	An enclosed flare will be used subject to the following requirements: 1) The flare operation shall be continuously monitored by continuous measurement of operation time of flare using a run time meter connected to a flame detector or a flame continuous temperature controller, irrespective of whether the flare efficiency is monitored. (2) Periodic measurement of methane content of flare exhaust gas. In fact, enclosed flares shall be monitored yearly, with the first measurement to be made at the time of installation. If this cannot be carried out, a default efficiency of 90% will be used. (3) The enclosed flares shall be operated and maintained as per the specifications prescribed by the manufacturer.
QA/QC procedures to be applied:	Regular maintenance should ensure optimal operation of flares.
Any comment:	

Data / Parameter:	$\mathbf{w_{CH4}}$
Data unit:	m^3 CH_4 / m^3 LFG
Description:	Methane fraction in the Landfill Gas
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	51%
Description of measurement methods and procedures to be applied:	Methane content will be measured continuously with a fixed gas analyser by the project developer. The gas analyser will be maintained and calibrated regularly in line with the manufacturer's requirements in order to ensure that factory standards of accuracy are maintained.
QA/QC procedures to	The gas analyser should be subject to a regular maintenance and testing

be applied:	regime to ensure accuracy.
Any comment:	

Data / Parameter:	$EG_{EX,LFG}$
Data unit:	MWh
Description:	Total amount of electricity exported out of the project boundary
Source of data to be used:	Project Developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	15,377 (average)
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously using an electricity meter which will be maintained and calibrated regularly to ensure that the accuracy of the measurement instrument is maintained.
QA/QC procedures to be applied:	Electricity meter will be maintained and calibrated regularly to assure high levels of accuracy.
Any comment:	Required to estimate the emission reductions from electricity generation from LFG, if credits are claimed.

Data / Parameter:	EL_{IMP}
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirements
Source of data to be used:	Grid operator
Value of data applied for the purpose of calculating expected emission reductions in section B.5	263
Description of measurement methods and procedures to be applied:	Electricity will be measured continuously using an electricity meter which will be maintained and calibrated regularly to ensure that the accuracy of the measurement instrument is maintained, The records of any electricity imported in the baseline too should be recorded at the start of project.
QA/QC procedures to be applied:	Measurements are to be cross-checked with invoices.
Any comment:	Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity.

Data / Parameter:	**Operation of the power plant**
Data unit:	hours
Description:	Operation of the power plant

Source of data to be used:	Project developer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8000 hours/year
Description of measurement methods and procedures to be applied:	Data will be recorded annually by the project developer to ensure methane destruction is claimed for methane used in electricity plant when it is operational.
QA/QC procedures to be applied:	Equipment will be maintained in line with manufacturer's recommendations to assure high quality output.
Any comment:	

B.7.2. Description of the monitoring plan:

The monitoring plan details the actions necessary to record all the variables and factors required by the methodology ACM0001, version 4, 28 July 2006 as detailed in section B.7.1 above. All data will be archived electronically, and backed up regularly. 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 fulfill their monitoring obligations. The authority and responsibility for project management, monitoring, measurement and reporting will be agreed between the project participants and formalized. 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: 19 September 2006

Person/entity determining the baseline:

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Detailed baseline and monitoring information are attached to Annex 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:

01/01/2007

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

More than 20 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:

01/01/2007

C.2.2.2. Length:

10 (ten) years

SECTION D. Environmental Impacts

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

The project will actively collect and combust LFG, thereby improving overall landfill management and reducing adverse global and local environmental effects of uncontrolled releases of landfill gas. While the main global environmental concern over gaseous emissions of methane is the fact that it is a potent greenhouse gas and thus contributes importantly 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 component contained in landfill gas.

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 removing safety risks from the surrounding community, reducing the risks of toxic effects on the local community and the local environment as well as reducing the emissions of a potent greenhouse gas.

It is worth noting that the Project Developer will install flares and electricity generation units 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 its minimising the negative effects of the LFG and thereby the risks of the landfill. Further it declares, that this presents a global and permanent impact of high magnitude and importance. [6]

Thus, the project activity can be referred as environmentally ameliorative and therefore can not be considered as subject of an environmental impact study in the Host Country accordant to the national Law N°19.300, article 11.

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.

An Environmental Impact Study for the landfill operation has been completed in accordance with the current regulations of the Host Country. It will be available for the validators on request.

[6] SIGEA (2006). Manifestación de Impacto Ambiental "Clausura y Ampliación del Relleno Sanitario de Ecatepec de Morelos, Estado de México". page 129, lines 13-15

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 7th of September 2006 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 to Energy Project undertaken by the Project Developer.

The event was properly announced in a national and in a local newspaper "El Día". 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 with appropriate formats kept in the Project Developer's files.

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 including 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 in specific as well as LFG capture in dump sites and landfills in general. Further factual issues about risk management in LFG projects were raised. The Project Developer explained briefly applied risk preventing procedures and all raised questions were answered to the complete satisfaction of the audience.
The stakeholders' consultation was videotaped and will be made available for the validators on request.

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

As indicated in Section E.2 above, there have been no formal comments submitted by any of the stakeholders regarding this project. Many of them had questions about specific parts of the project and/or the future management of the landfills, and those 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

Project developer:

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Project Annex 1 participant:

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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**
	Landfill data	
Year landfill started operation		1981
Waste in place at the beginning of project	tonnes	1,994,000
Density of waste	tonnes/m^3	0.8
Area of site	Ha	34
Average daily waste rate	tonnes/day	400
Date gas collection project starts		01-Jan-2007
	Operational data	
Gas collection efficiency	%	65%
Flare efficiency	%	99%
	General data	
Lo	m^3/tonne	160.0
k	1/yr	0.12
Methane content of landfill gas	%	51%
CH4 GWP	T CO_2/T CH4	21
Density of Methane	Tonne/CH4/m^3	0.0007168
	Baseline data	
Proportion of methane flared in Baseline (AF)	%	5%

Table: Proprietary decay model used to estimate emission reductions.

Proprietary first order decay model (based on US EPA model)

$$\sum_{i=1}^{n} 2\, k\, L_0\, M\, e^{-kt_i}$$

Lo = methane generation potential (m3/ton)
M = mass of waste deposited (tonnes) in year "i"
k = refuse decay rate (1/year)
ti = age of waste (years) in year "i"

Input data for the Electricity Generation component of the Project Activity

Input data	
PROJECT DATA	
Date project starts operating (year)	**2007**
Installed capacity (MW)	**2.30**
Estimated on-line availability of equipment (%)	**91%**
Operating period (h/yr)	**8,000**
BASELINE DATA	
Country	**Chile**
CEF country (t CO2e/MWh)	**0.264**
Crediting period (years)	**10**
FINANCIAL PARAMETERS	
Electricity tariff (US cents/KWh)	**5.8**
Rate of increase of tariff (%/yr)	**1.5%**
Income tax	**17.0%**
Discount rate	**12.0%**
Depreciation	**10.0%**
Price of carbon (US$/tCO2)	**7.00**

Carbon Emission factors of the Electricity Grid "SIC"

Operating Margin of the Chilean Electricity Grid	**2003**	**2004**	**2005**
Electricity Generation (GWh)	32,935	36,154	37,807
Carbon Emissions (tCO_2)	7,337,312	9,930,011	8,730,639
Operating Margin (tCO_2 / MWh)	0.223	0.275	0.231
Weighted Average Operating Margin (tCO_2 / MWh)	**0.243**		

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

Build Margin of the Chilean Electricity Grid	**2005**
Electricity Generation (GWh)	7,570

Carbon Emissions (tCO_2)	2,162,224
Build Margin (tCO_2 / MWh)	**0.286**

Carbon Emission Factor	**tCO_2/MWh**
Average Operating Margin 2003-2005	0.243
Build Margin 2005	0.286
Carbon Emission Factor	**0.264**

Operating Margin of the Chilean Electricity Grid "SIC" 2003 – 2005

Group of plants (grouped in fired-fuel types)	year connected to the grid	type of principal fuel and [alternative]	Gross Generation in GWh	Gross Generation in GWh	Gross Generation in GWh	annual consumption of: liquid fuels in thousand tons			coal in thousand tons			natural gas in MM-m3 Standard			Carbon Emissions in tCO_2	Carbon Emissions in tCO_2	Carbon Emissions in tCO_2
			2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
			Total	Total	Total												
Lag. Verde	1939/49	Coal	0.0	38.5	80.3	-	-	-	0	26.49	55.25	-	-	-	0.00	70,482.46	147,004.76
Ventanas 1	1964	Coal	31.3	413.4	324.1	-	-	-	12.45	154.31	120.95	-	-	-	33,125.96	410,575.64	321,814.04
Huasco-Vapor	1965	Coal [Petrol]	0.0	4.1	11.1	0.00	0.74	0.00	0	3.96	10.72	-	-	-	0.00	12,887.59	28,522.91
Bocamina	1970	Coal	210.9	300.1	423.7	-	-	-	76.36	112.93	159.44	-	-	-	203,172.55	300,475.06	424,225.13
Ventanas 2	1977	Coal	393.2	1,050.8	841.0	-	-	-	154.94	391.58	313.39	-	-	-	412,251.89	1,041,884.58	833,842.92
Guacolda I	1995	Coal [Petrol]	1,218.8	1,240.8	1,109.3	-	-	-	438.70	459.86	416.20	-	-	-	1,167,257.69	1,223,558.52	1,107,391.50
Guacolda II	1996	Coal [Petrol]	1,230.7	1,127.4	1,110.8	-	-	-	442.91	458.09	410.10	-	-	-	1,178,459.32	1,218,849.04	1,091,161.11
Petropower	1998	Petcoke	482.6	526.2	365.9	-			151.10	164.70	176.86	-	-	-	402,034.73	438,220.52	470,574.87
Nueva Renca	1997	natural Gas [Petrol Diesel] CCGT	1,856.6	2,275.6	1,856.6	0.00	2.43	22.61	-	-	-	495.94	449.73	359.77	1,210,951.42	1,105,839.72	950,297.93
San Isidro	1998	natural Gas [Petrol Diesel] CCGT	2,263.4	2,706.3	1,214.4	0.00	0.00	27.67	-	-	-	448.39	532.39	227.30	1,094,847.17	1,299,952.47	642,918.71
Nehuenco	1998	natural Gas [Petrol Diesel] CCGT	2,474.3	1,848.0	949.0	0.00	9.00	115.95	-	-	-	481.41	351.77	65.12	1,175,473.09	887,522.19	527,403.58
Taltal 1+ 2	2000	natural Gas [Petrol Diesel] OCGT	529.3	988.7	973.9	0.00	0.00	0.04	-	-	-	175.00	327.09	322.02	427,302.69	798,665.36	786,412.88
Nehuenco 9B	2002	natural Gas [Petrol Diesel]	16.0	107.6	103.0	0.00	7.97	7.34	-	-	-	5.49	23.57	13.84	13,405.10	82,873.98	53,381.29
Nehuenco II	2003	natural Gas CCGT	39.4	1,996.2	2,383.7	-	-	-	-	-	-	6.87	395.28	472.00	16,774.68	965,166.91	1,152,496.41
Horcones TG	2004	natural Gas	-	12.2	2.0	-	-	-	-	-	-	0	4.09	0.71	0.00	9,989.00	1,733.63
Candelaria	2005	natural Gas [Petrol Diesel] CCGT	-	-	26.9	-	-	-	-	-	-	0	0	5.33	0.00	0.00	13,014.42
Coronel TG	2005	Gas [Petrol Diesel]	-	-	69.0	0.00	0.00	0.94	-	-	-	0	0	21.04	0.00	0.00	48,685.54
Renca	1962	Petrol Diesel A-1	0.0	6.7	24.1	0.00	1.34	6.93	-	-	-	-	-	-	0.00	4,257.47	22,018.10
Huasco Fuel	1977/1979	Petrol Diesel [Petrol IFO-180]	0.5	29.1	57.1	0.29	10.75	0.16	-	-	-	-	-	-	921.39	34,155.07	508.35
D. de Almagro	1981	Petrol Diesel	0.4	6.2	0.4	0.28	2.29	0.17	-	-	-	-	-	-	889.62	7,275.82	540.13
S. Fco. Mostazal	2002	Petrol Diesel	0.0	9.3	18.9	0.14	3.16	6.37	-	-	-	-	-	-	444.81	10,040.00	20,238.86
Lag. Verde TG	2004	Petrol Diesel	-	8.7	17.2	0.00	2.31	21.43	-	-	-	-	-	-	0.00	7,339.37	68,087.73
Antilhue TG	2005	Petrol Diesel	-	0.8	49.5	0.00	0.00	5.78	-	-	-	-	-	-	0.00	0.00	18,364.31
Constitución	1995	Biomass	56.3	50.0	55.9										0	0	0
Arauco	1996	Biomass	146.1	155.9	16.1										0	0	0
Celco	1996	Biomass	123.8	132.5	73.8										0	0	0
Cholguán	2003	Biomass	66.3	93.2	79.2										0	0	0
Laja	1995	Biomass	37.2	39.3	38.6										0	0	0
Licantén	2004	Biomass	-	21.2	21.7										0	0	0
Valdivia	2004	Biomass	-	155.7	157.6										0	0	0
Florida	1909/93	Hydro	125.0	138.3	166.9										0	0	0
Maitenes	1923/1989	Hydro	137.4	132.2	132.5										0	0	0
Queltehues	1928	Hydro	376.4	357.7	366.8										0	0	0
Volcán	1944	Hydro	111.1	95.0	109.2										0	0	0
Sauz+Szito	1948/1959	Hydro	577.7	558.9	623.3										0	0	0
Abanico	1948/1959	Hydro	403.5	355.3	356.3										0	0	0
Los Molles (Reg IV)	1952	Hydro	93.4	45.9	62.0										0	0	0
Cipreses	1955	Hydro	616.0	436.8	456.3										0	0	0
Isla	1963/1964	Hydro	539.1	479.4	496.4										0	0	0
Rapel	1968	Hydro	946.4	795.7	1,345.3										0	0	0
El Toro	1973	Hydro	2,306.5	1,694.4	1,080.3										0	0	0
Antuco	1981	Hydro	1,887.1	1,662.5	1,573.9										0	0	0
Colbún+Machicura	1985	Hydro	3,011.9	2,474.7	3,700.5										0	0	0
Canutillar	1990	Hydro	1,083.3	1,094.6	902.4										0	0	0
Pilmaiquén	1944/45/59	Hydro	263.3	265.7	253.2										0	0	0
Pullinque	1962	Hydro	242.8	231.3	248.7										0	0	0
Los Quilos	1943/89	Hydro	288.1	244.2	276.8										0	0	0
Alfalfal	1991	Hydro	791.8	840.9	878.5										0	0	0
Pehuenche	1991	Hydro	2,690.9	2,566.5	3,143.0										0	0	0
Curillinque	1993	Hydro	691.0	628.0	647.5										0	0	0
Aconcagua	1993/94	Hydro	438.9	370.7	431.1										0	0	0
Capullo	1995	Hydro	77.2	74.6	75.0										0	0	0
Pangue	1996	Hydro	1,681.4	1,675.6	2,246.6										0	0	0
San Ignacio	1996	Hydro	210.5	182.4	261.9										0	0	0
Loma Alta	1997	Hydro	297.4	276.9	279.2										0	0	0
Puntilla	1997	Hydro	119.5	118.2	114.0										0	0	0
Rucúe	1998	Hydro	1,175.8	1,091.2	969.5										0	0	0
Peuchén	2000	Hydro	237.4	262.2	294.7										0	0	0
Mampil	2000	Hydro	156.5	174.1	192.8										0	0	0
Chacabuquito	2002	Hydro	180.3	152.9	171.9										0	0	0
Ralco	2004	Hydro	-	1,332.3	3,495.8										0	0	0
			Gross Generation 2003 in GWh	Gross Generation 2004 in GWh	Gross Generation 2005 in GWh										Total Carbon Emission 2003	Total Carbon Emission 2004	Total Carbon Emission 2005
			32,934.7	36,153.6	37,807.1										7,337,312.12	9,930,010.77	8,730,639.12

Build Margin of the Chilean Electricity Grid "SIC" 2005

Name of Power Plant		type of principal fuel and [alternative]	Power Plant capacity additions that comprise 20% of system generation	5 most recent Power Plants	Carbon Emissions	Build Margin 2005
			GWh 2005	GWh 2005	tCO_2	tCO_2 / MWh
Taltal 1+ 2	2000	natural Gas [Petrol Diesel]	**973.9**		786,412.88	
Nehuenco 9B	2002	natural Gas [Petrol Diesel]	**103.0**		53,381.29	
S. Fco. Mostazal	2002	Petrol Diesel	**18.9**		20,238.86	
Chacabuquito	2002	Hydro	**171.9**		0	
Nehuenco II	2003	natural Gas	**2383.7**		1,152,496.41	
Cholguán	2003	Biomass	**79.2**		0	
Ralco	2004	Hydro	**3495.8**		0	
Lag. Verde TG	2004	Petrol Diesel	**17.2**		68,087.73	
Licantén	2004	Biomass	**21.7**		0	
Valdivia	2004	Biomass	**157.6**	**157.6**	0	
Antilhue TG	2005	Petrol Diesel	**49.5**	**49.5**	18,364.31	
Horcones TG	2004	natural Gas	**2.0**	**2.0**	1,733.63	
Candelaria	2005	natural Gas [Petrol Diesel]	**26.9**	**26.9**	13,014.42	
Coronel TG	2005	Gas [Petrol Diesel]	**69.0**	**69.0**	48,685.54	
Gross Generation of selected power plants (20% of system generation)m in GWh			**7,570.3**	**305.0**	2,162,415.07	**0.285644568**
20% of system generation in GWh			**7,561.4**			
SIC system generation in GWh			**37,807.1**			

Applied Conversion Factors

Natural Gas (NG)		
NCV	9300	kcal/Sm^3 (http://www.gasvalpo.cl/conozca/preguntas.html)
1 Joule =	0.000239006	kcal
Conversion J/kcal	4184.00	
Emission Factor for OCGT and CCGT	17.2	tC/TJ (Source: IPCC 1996)
Emission Factor (not specified technology)	15.3	tC/TJ
Oxidation Factor NG	0.995	(Source: 1996 IPCC Guidelines for national greenhouse gas inventories)
Petrol Diesel (PD)		
NCV	43.33	TJ/10^3 tonne of fuel (Source: 1996 IPCC Guidelines for national greenhouse gas inventories)
Emission Factor	20.2	tC/TJ (Source: IPCC 1996)
Oxidation Factor PD	0.99	(Source: 1996 IPCC Guidelines for national greenhouse gas inventories)
Coal		
NCV	0.0287	TJ/tonne of coal (Source: 1996 IPCC Guidelines for national greenhouse gas inventories)
Emission Factor	25.8	tC/TJ (Source: IPCC 1996)
Oxidation Factor	0.98	(Source: 1996 IPCC Guidelines for national greenhouse gas inventories)
Conversion CO_2/C	3.666666667	tCO2/tC

CER CALCULATION

Year		0	1	2	3	4	5	6	7	8	9	10	Total	Average
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		
Methane Destruction														
m3 LFG collected per hour		0	1,426	1,460	1,495	1,532	1,569	1,608	1,648	1,690	1,499	1,329	15,255	1,526
m3 LFG collected per year		0	12,490,245	12,788,215	13,096,960	13,416,418	13,746,564	14,087,405	14,438,983	14,801,363	13,127,631	11,643,164	133,636,948	13,363,695
m3 LFG consumption per MWh generated	650													
Total m3 LFG combusted in power generation		0	0	11,960,000	11,960,000	11,960,000	11,960,000	11,960,000	11,960,000	11,960,000	11,960,000	5,980,000	101,660,000	10,166,000
Total m3 LFG flared		0	12,490,245	828,215	1,136,960	1,456,418	1,786,564	2,127,405	2,478,983	2,841,363	1,167,631	5,663,164	31,976,948	3,197,695
Concentration CH4 (m3CH4/m3LFG)	51%													
Density CH4 (tonne/m3)	0.0007168													
Flare Efficiency	99%													
Global Warming Potential (GWP) CH4	21													
Tons of CO2e combusted in power generation		0	0	91,521	91,521	91,521	91,521	91,521	91,521	91,521	91,521	45,761	777,932	77,793
Tons of CO2e flared		0	94,623	6,274	8,613	11,033	13,535	16,117	18,780	21,525	8,846	42,903	242,250	24,225
Tons of CO2e destroyed in project (tonnes CO2e/yr)		0	94,623	97,796	100,135	102,555	105,056	107,638	110,302	113,047	100,367	88,663	1,020,182	102,018
Tons of CO2e destroyed in baseline (AF)	5%	0	4,731	4,890	5,007	5,128	5,253	5,382	5,515	5,652	5,018	4,433	51,009	5,101
Tons of CO2e destroyed (net)		0	89,892	92,906	95,128	97,427	99,803	102,256	104,786	107,395	95,349	84,230	**969,172**	**96,917**
Power Generation (Grid electricity displacement)														
Installed capacity (MW)	2.30	0.00	0.00	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	1.15		
Number of operating hours per year/MW	8,000													
Electricity Generation (MWh/year)		0	0	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	9,200	156,400	15,640
Electricity Consumption by the project (MWh/year)	263	0	263	263	263	263	263	263	263	263	263	263	2,628	263
Net Electricity Exports: (MWh/year)		0	-263	18,137	18,137	18,137	18,137	18,137	18,137	18,137	18,137	8,937	153,772	15,377
Baseline emission reductions - Grid electricity														
CEF (tCO_2 / MWh)		0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264		
Baseline emission reductions (tCO2/year)		-	-	4,788	4,788	4,788	4,788	4,788	4,788	4,788	4,788	2,359	40,665	4,067
Cummulative baseline emission reductions (tCO2)		-	-	4,788	9,576	14,365	19,153	23,941	28,729	33,518	38,306	40,665	213,041	21,304
Project emissions - Net Electricity consumption														
CEF (tCO2/MWh)		0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264	0.264		
Project Emissions (tCO2/year)		**-**	- 69	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-69	-7
Cummulative project emissions (tCO2)		-	- 69	- 69	- 69	- 69	- 69	- 69	- 69	- 69	- 69	- 69	-694	-69
Emission reductions														
Total emission reductions from methane destruction		-	89,892	92,906	95,128	97,427	99,803	102,256	104,786	107,395	95,349	84,230	969,172	96,917
Emission reductions due to grid displacement (tonnes CO2e/yr)		-	-	4,788	4,788	4,788	4,788	4,788	4,788	4,788	4,788	2,359	40,665	4,067
Project emissions			- 69	-	-	-	-	-	-	-	-	-		
Net Emission Reductions (tCO2/yr)		**-**	**89,823**	**97,694**	**99,916**	**102,215**	**104,591**	**107,044**	**109,575**	**112,183**	**100,137**	**86,590**	**1,009,768**	**100,977**
Cummulative (tCO2)		-	89,823	187,517	287,433	389,648	494,240	**601,284**	710,859	823,042	923,179	**1,009,768**		

Annex 4

MONITORING INFORMATION

Table 4: Operational procedures and responsibilities for monitoring and quality assurance of emission reductions from the project activity (E = responsible for executing data collection, R = responsible for overseeing and assuring quality, I = to be informed)

Task	Site Operators	Site Manager	Regional Manager	External Data provider (Gás Data)	Equipment Supplier / External Company	Biogas Technology Data Manager	EcoSecuritie s
Daily Data Gathering	E	R	R	E	N/A	I	N/A
Enter data into data gathering sheet	E	R	R	N/A	N/A	R	N/A
Download data from external data provider	N/A	N/A	N/A	I	N/A	E	I
CER calculation	N/A	N/A	N/A	I	N/A	E	I
Make monthly & annual reports	I	I	I	N/A	N/A	E	R
Archive monthly and annual data and reports	N/A	N/A	N/A	N/A	N/A	E	N/A
Calibration/ Maintenance; Rectify faults	I	I	I	E	E	R	I