CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Copiulemu landfill gas project (Center for the Storage and Transfer, Recovery and Control of Waste, Treatment and Disposal of Industrial and Household Waste)

A.2. Description of the project activity:

The Copiulemu landfill is an existing and operational landfill site. It is suited for municipal and industrial solid waste management for various reasons: it is located conveniently to all communities, far away from local small communities, near a main road and 20 km from Concepción metropolitan area communities. It employs leading edge technology to enhance environmental protection. The landfill is planned, designed and operated in a manner to reduce risks to human health and the environment, and a system for the treatment of leachate is already operational.

The purpose of the Copiulemu landfill gas project is to install a highly efficient landfill gas collection system. This will involve investing in a gas collection system, airtight covering of the landfill, and flaring equipment.

The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. The release of landfill gas can have a negative impact on the health of the local environment and the local population and lead to risks of explosions in the local surroundings. The project will also have a small, but positive impact on employment in the local area as a number of staff will need to be recruited to manage the landfill gas operations.

At the initial stage of the project, no electricity will be generated from the collected biogas. This is due to the high investment costs in power generation equipment and grid connection and the current low price of electricity. Another reason is the relatively low estimate of power capacity (2 to 4 MW) that can be generated, and the uncertainty and variation in the actual production of biogas. The feasibility of electricity generation will be revisited once the project is operational.

The project is helping the Host Country fulfil its goals of promoting sustainable development. Specifically, the project:

- Increases employment opportunities in the area where the project is located;
- Uses clean and efficient technologies;
- Acts as a clean technology demonstration project;
- Optimises the use of natural resources, avoid uncontrolled waste management.

A.3. Project participants:

Copiulemu S.A., a Chilean company specializing in the treatment of industrial and household waste substances in the 8th Region. Copiulemu is a subsidiary of the Belgian Group Machiels.

Further contact information of the project participant 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):

Chile

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

Región VIII: Región del Bíobío.

A.4.1.3. City/Town/Community etc:

Copiulemu, near the city Concepción.

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

The Copiulemu Landfill is located 20 Km to the North East of the City of Concepcion, on the Road O-59 to Cabrero, on the Florida County and specifically in the Copiulemu area. Geographically the site is referred to the UTM cuadrant as: N5198300 and 5198400, and E 691200 and 691300.

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

Sectoral Category 13 - Waste handling and disposal

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

The Copiulemu Landfill consists of a sloped landfill placed in a basin limited downstream by a closing earth wall. All the bottom and slope surfaces are lined with a double impermeable system designed and constructed according to international standards. A sub-superficial drainage system based in gravel blankets and drains maintains the phreatic water levels controlled below the landfill drainage. To complement the design, a leachate collection and recovery system designed to serve even under the local rainy conditions, connects to three lined ponds and to a water treatment plant.

Landfill gas collection system:
State-of-the-art gas collection technology will be used. This includes:

- vertical wells used to extract gas;
- optimal well spacing for maximum gas collection (9-12 wells per hectare);

- gas headers designed as a looping system in order to allow for partial or total loss of header function in one direction without losing gas system functionality, and
- condensate extraction and storage systems designed at strategic low points throughout the gas system.

All efforts will be made to minimize problems in condensate management.

The best currently available technology was considered and included in the design and construction of the Copiulemu Landfill. Machiels permanently is transferring European technology to improve the operation and handling of wastes. Leading edge waste compaction, transport and handling equipments are important part of Machiels' efforts to contribute to an environmentally friendly project. Other improvements in the water treatment plant and laboratory will be continuously introduced.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The proposed project involves the collection and combustion of landfill gas that is currently released into the atmosphere, thus converting its methane content into CO_2 and reducing its greenhouse gas effect.

There is currently no system in place for the capture and flaring of landfill gas. The permit for the Copiulemu landfill site does specify that a system for capture and flaring of the gas needs to be in place, but the technical requirements in the permit would lead to the capture and destruction of only a small percentage of the methane produced by the landfill.

The baseline scenario is defined as the most likely future scenario in the absence of the proposed CDM project activity. Establishing this future scenario requires an analysis and comparison of possible future scenarios using a comparison methodology that is justified for the project circumstances. Based on this analysis (see section B below), the baseline scenario is the continued release of the majority of the landfill gas to the atmosphere, similar to the current practice of most landfills in Chile.

A technical analysis was conducted in order to quantify the potential volume of emissions reductions that the project can generate. The analysis was conducted based on the projections of carbon emissions for the project and its baseline. It was found that the project has the capacity to generate 2,902,156 tonnes of CO_2e reductions over its 21-year lifetime.

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. Given this, the project is not part of the baseline scenario and it can be concluded that the project is additional (see B.3).

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

This project is expected to avoid 630,878 tCO_2e emissions over the first seven year crediting period, and 2,902,156 tCO_2e over 21 years.

Refer to section E for further details on the quantification of GHG emission reductions associated with the project.

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, it is financed only with private capital.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

According to the UNFCCC's Drafting Group on Technical Issues text on CDM (Decision-/CP.7 Article 12, Paragraph 48) a project must select a baseline approach relevant to the activity.

The baseline approach adopted for the Copiulemu project is option 48(b) of the Marrakech text: The baseline is the scenario that represents "emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

ACM0001, the "Consolidated baseline methodology for landfill gas project activities", has been applied to this project.

A justification of the method's appropriateness given the project circumstances are given below.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The *consolidated baseline methodology for landfill gas project activities* is applicable where the baseline is either partial or total atmospheric release of the gas and the project activity either flares or utilizes the captured gas.

The Copiulemu project involves the situation listed under a) in the baseline methodology, as the captured gas will only be flared in the project, and not used to produce electricity. The project baseline is the partial atmospheric release of the gas. The Copiulemu project thus meets the applicability requirements as described in the *consolidated baseline methodology for landfill gas project activities*.

The selected approach from paragraph 48 of the CDM modalities and procedures in this methodology is: "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment." This approach is appropriate for this project, as the project involves a significant investment that would not have any financial return without CER revenue.

B.2. Description of how the methodology is applied in the context of the project activity:

The consolidated methodology for landfill gas project activities provides instructions and a formula for calculating the emission reductions of a landfill project. Since the Copiulemu project only involves flaring, this formula can be simplified as follows:

$$ER_y = (MDproject_y - MDreg_y) * GWP\_CH_4$$

Where ER_y is the greenhouse gas emission reduction achieved by the project activity during a given year "y", calculated as the difference between the amount of methane actually destroyed/combusted during the year ($MDproject_y$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MDreg_y$) times the approved Global Warming Potential value for methane (GWP_CH4).

ER_y is measured in tonnes of CO_2 equivalents (tCO_2e). $MDproject_y$ and $MDreg_y$ are measured in tonnes of methane (tCH_4). The approved Global Warming Potential value for methane (GWP_CH_4) for the first commitment period is 21 tCO_2e/tCH_4.

Since regulatory requirements have not specified the quantity of MDreg, an "Adjustment Factor" (AF) for determining the baseline is used.

The percentage value for the Adjustment Factor (AF)

The *Resolución Exenta Nº 081/2000*, the permit for the Copiulemu landfill (published and signed on March 9, 2000) requires the capture of some of the landfill gas to prevent the risk of explosions.[1] The permit specifies that there should be 2 to 3 wells per hectare to capture the gas. The permit also specifies the diameter of the piping and depth and construction of the wells.

With 2 to 3 wells per hectare, it would only be possible to capture a small proportion of the landfill gas. In order to establish how much gas could be captured and what system should be installed, an assessment of the Copiulemu landfill was made by ZEIDON LTDA, an environmental consultancy agency with expertise in landfill gas.[2] In their report, ZEIDON conclude that the influence range of a well is less than 20 meters. Their recommendation is to install at least 9-12 wells per hectare to capture the landfill gas effectively.

The baseline for the Copiulemu project would be to meet the minimum requirements of the permit, i.e. the 2 to 3 wells per hectare. As there are no economic benefits to install a larger and more expensive gas capture system, it would make no sense to do more than the permit requires.[3] The ZEIDON report establishes that with 3 wells per acre, 14% of the total produced landfill gas would

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[1] The permit for Copiulemu is valid for the currently existing capacity for receiving waste. The remaining capacity as of November 2004 is to receive approximately 2 million tonnes of waste. Given the expected annual volume of waste of 100,000 tonnes per year, this means the current site could remain operational until approximately 2024 under the current permit requirements.

[2] "ESTUDIO GENERACION DE BIOGAS EN RELLENO SANITARIO DE COPIULEMU", Asesorías Ambientales e Industriales ZEIDON LTDA. Los Cedros Nº 3600 – Macul – Santiago – Fono Fax (02) 314 2925 – Teléfono Móvil 98241411 – E mail : zeidonltda@vtr.net.

[3] In fact, many landfills in Chile do not meet permit requirements on gas capture at all.

be captured. This figure needs to be adjusted for the fact that not all the produced landfill gas will be captured by the project. *The expected collection efficiency of the landfill gas extraction system is estimated at 90% by experts from Copiulemu and Group Machiels*. This means that 90% of the produced landfill gas will be captured by the landfill gas extraction system. To obtain the correct AF the efficiency of the landfill gas extraction system will need to be combined with the percentage of the total extracted landfill gas by the three installed wells. The AF will be obtained by multiplying the percentage of the landfill gas which will be extracted using 3 wells with the efficiency of these wells. Taking a more conservative 85% for the extraction efficiency for the wells, this leads to an Adjustment Factor for the formula above of 16.5%. The AF used in the model calculations is 17%.

This is a conservative approach, because:

- The environmental permit of the landfill requires the installation of 2 or 3 landfill gas extraction wells per ha. In the calculation it is assumed that 3 wells per ha will be installed. While it is likely that 2 wells will be installed, because that would comply with the permit.
- The estimated efficiency of the gas extraction wells which is used to determine the AF is lower than the expert figure.

Currently the Chilean Ministry of Health is developing legislation at the national level that would also involve an obligation to capture and flare part of the landfill gas. The purpose of this obligation is to prevent the risks of explosions. This legislation is still at a draft stage and it has not been decided yet what percentage has to be flared. In the various discussions that were held with stakeholders, percentages for the capture and flare obligation varying from 10 – 20 percent were mentioned.

However, under Chilean law, such new legislation could not apply to landfills that are already operating under an existing permit.[4] Since the current permit for Copiulemu is valid until approximately 2024 (see footnote 1), the new national legislation could not apply to the site before that date. The legislation will not affect the Copiulemu baseline and the Adjustment Factor during at least the first crediting period.

Having established the Adjustment Factor, the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MDreg_y$) is calculated as follows:

$$\mathbf{MDreg_y = MDproject_y * AF \text{ (where AF=17\%)}}$$

As specified by the consolidated methodology, the ex ante emission reduction estimates are made by projecting the future GHG emissions of the landfill. The US EPA First Order Decay Model is used to perform these calculations.

The actual emission reductions will be determined (*ex post*) by metering the actual quantity of methane captured and destroyed once the project activity is operational.

[4] Source: Jaime Dinamarca Garate, lawyer at the Chilean Federation of Industry (SOFOFA), phone : 0056 2 391 3180, email: jdinamarca@sofofa.cl.

B.3. 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:

The determination of additionality is done using the CDM consolidated tool for demonstration of additionality, which follows the following steps:

Step 0. Preliminary screening of projects started after 1 January 2000 and prior to 31 December 2005

The project is only expected to start operation after its registration as a CDM project with the UNFCCC. In any case, as it will be demonstrated in the following steps, CDM revenue has been considered from the early stages of development of the project, and it is an integral part of the financial package of the project.

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

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

Alternative 1: The Business as Usual scenario. Although there is currently no capture and destruction of methane at the Copiulemu landfill site, the BAU scenario does take into account that a part of the methane would be captured in the near future to comply with regulations. In this scenario, the landfill operator would invest in a gas capturing system that meets the minimum requirements of the permit. The release of a large part of the landfill gas into the atmosphere would continue.

Alternative 2: The landfill operator would invest in LFG collection equipment, power generation equipment and a grid connection, to supply power to the Chilean grid.

Alternative 3: The landfill operator would invest in a landfill gas collection system of high effectiveness, as well as a high efficiency flaring system (the proposed project activity).

Other scenario's for a landfill might be the utilization of the landfill gas to supply heat, steam, or the upgrade of the landfill gas to natural gas quality. For Copiulemu, none of these scenario's are plausible, as the landfill is too small to make such utilization economically feasible. There is no industry to which heat or gas could be supplied in the vicinity of the landfill site and the nearest village is 6 km away. A connection to the natural gas grid and equipment to upgrade the biogas to natural gas quality are too expensive.

Sub-step 1b. Compliance with applicable laws and regulations:

All the alternatives comply with the laws and regulatory requirements in the project location.
As explained under B.2., new landfill legislation in Chile would not apply to Copiulemu, as it operates under an existing permit, and the Business as Usual scenario is a scenario where Copiulemu will meet all the permit requirements.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the methodology for determination of additionality, option I should be used if the CDM project activity generates no financial or economic benefits other than CDM related income. As this is the case for Copiulemu, the simple cost analysis will be used. To show that electricity production is not a viable baseline alternative, the benchmark analysis of option III will be used as well.

Sub-step 2b: Option I + III – simple cost analysis and application of benchmark analysis

Simple cost analysis
Alternative 3 (the project activity) will involve extra investments in an efficient gas collection system, airtight covering of the landfill, and flaring equipment.

The extra investments are estimated at approximately €1,500,000.

By investing in a gas capturing system, Copiulemu will not generate any revenues in the absence of CDM. Alternative 3 is therefore not an economically attractive scenario and not a realistic baseline scenario.

Benchmark analysis
The likelihood of Alternative 2, as opposed to the Business as Usual scenario will be determined by comparing its IRR with the benchmark of the interest rate available to a local investor, i.e., as provided by local banks in Chile. A very conservative interest rate of 4% has been used in the analysis.

Sub-step 2c: Comparison of financial indicators

The Table below shows the financial analysis for Alternative 2. As shown, the project IRR (without carbon) is -8%. As the project IRR is negative, the Net Present Value will be negative at any interest rate and Alternative 2 is thus not a viable baseline alternative.

Table: Financial results of Alternative 2 without carbon finance. NPV uses 4% discount rate.
Summary of results of project analysis.

Net Present Value (US$)	- 893,139
IRR	Negative
Discount rate	4%

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).

Those parameters were selected as being the most likely to fluctuate over time. Financial analyses were performed altering each of these parameters by 15 %, and assessing what the impact on the project IRR would be (see Table below). As can be seen, the project IRR remains negative even in the case where these parameters change in favour of the project.

Net Present Value (US$)	**IRR (%)**	**NPV (US$)**
Original	Negative	-893,139
Increase in project revenue	-1.14%	-326,440
Reduction in project costs	-1.03%	-283,249

Note: NPV uses 4% discount rate.

Step 4. Common Practice Analysis

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

To date there has been limited development of landfill gas projects in the Host Country, as it can be seen in the Table below that lists a series of landfills in the Host Country.

Although permits for new landfills in Chile often mention gas capture and flaring, the current practice in Chile is either no flaring at all or the unmanaged flaring of some of the gas.

The current Chilean national legislation does not require that landfills collect and dispose of landfill gases. So far, only a few landfills in Chile have been designed to collect and partially flare the gas generated. In the few cases where gases are collected, this is done for safety reasons (to avoid explosions), and it is often the case that the amounts effectively collected are very low. Investments done with this purpose is low and the technology used is very poor, with few exceptions.

Currently, only one landfill in Santiago is implementing a flaring system and a second one is installing a collecting system, but all over the country this is the case for less than three percent of the landfills.

In the VIII Region, only two out of thirty landfill that are operating with a valid permit are working on gas capturing, one of them being the proposed projects. Another three landfills that were recently closed by sanitary authorities have no gas control at all.

There are some preliminary plans to install efficient capture and flaring systems for other landfills, but these are all in the context of CDM.

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

Where other similar projects are planned, these are all to be developed under the CDM. This does not call into question the claim that the Copiulemu project is financially unattractive without the CDM.

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. As the project will generate 2,902,156 tCO_2e over its 21-year lifetime, the revenue generated by carbon sales would be sufficient to make the project go ahead. Approval and registration as a CDM activity will thus alleviate the economic and financial hurdles.

According to the above analysis, the Copiulemu project is not the baseline scenario.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

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

Table B.4 –project and system boundaries

Emissions	**Project Scenario**	**Baseline Scenario**
Direct on-site	Emissions associated with fugitive landfill gas emissions. It has been estimated that approximately 90% of the landfill gas generated will be captured.	Uncontrolled release of landfill gas generated.
Direct off-site	Transportation of equipment to project site – excluded	Transportation of equipment to project site – excluded
Indirect on-site	Emissions from construction of the project (gas collection and flaring system). These emissions are excluded as they are not under control of the project developer and are insignificant (less than 1%) compared to the total emissions. constructed.	Emissions from construction of a less effective capturing system.
Indirect off-site	Transport of waste to the landfill site(s) – excluded	Transport of waste to the landfill site(s) - excluded

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

The baseline study was concluded in November 2004.

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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:

Estimated at 15/01/2006 (starting date of the project activity is defined as the start of the actual gas capture)

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

25 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:

Estimated at 15/01/2006

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

C.2.2.2. Length:

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

ACM0001 “Consolidated monitoring methodology for landfill project activities”

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

The chosen methodology is to be used in conjunction with baseline methodology ACM0001. The Copiulemu project involves the situation listed under a) in the monitoring methodology, as the captured gas will be flared in the project. The project baseline is the partial atmospheric release of the gas. The Copiulemu project thus meets the applicability requirements as described in the *consolidated monitoring methodology for landfill gas project activities*.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

Option 2 is chosen here, see 2.2

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

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D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

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D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number	Data variable	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
1. LFG For MD $project_y$	Total amount of landfill gas captured	m^3	M	Continuously/periodically	100%	electronic	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly.
2. LFG for MD $flared_y$	Amount of landfill gas flared	m^3	M	Continuously/periodically	100%	electronic	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly.
3. FE	Flare/combustion efficiency, determined by the operation hours (1) and the methane content in the exhaust gas (2)	%	m/c	(1) continuously (2) quarterly, monthly if unstable	n/a	electronic	During the crediting period and two years after	(1) Periodic measurement of methane content of flare exhaust gas. (2) Continuous measurement of operation time of flare (e.g. with temperature)
4. $F_{CH4,y}$	Methane fraction in the landfill gas	m^3 CH_4/ m^3 LFG	M	Continuously/periodically	100%	electronic	During the crediting period and two years after	Measured by continuous gas quality analyser.

5. T	Temperature of the landfill gas	ºC	m	Continuously/periodically	100%	electronic	During the crediting period and two years after	Measured to determine the density of methane D_{CH4}
6. p	Pressure of the landfill gas	Pa	m	Continuously/periodically	100%	electronic	During the crediting period and two years after	Measured to determine the density of methane D_{CH4}
7.	Regulatory requirements relating to landfill gas projects (used to recalculate AF)	Text	n/a	Annually	100%	electronic	During the crediting period and two years after	Required for any changes to the adjustment factor (AF) or directly $MD_{reg,y}$
8	Total amount of electricity and/or other energy carriers used in the project for gas pumping and heat transport (not derived from thegas)	MWh	m	Continually	100%	Electronic	Duriong the crediting period and two years after	Required to determine CO2 emissions from use of electricity or other energy carriers to operate the project activity.

9	CO2 emission intensity of the electricity and/or other energy carriers in ID 8.	CO2e/ MWh	c	Annually	100%	electronic	Duriong the crediting period and two years after	Required for any changes to the adjustment factor (AF) or directly MDreg,y. In the monitoring section of the PDD the emission reductions which result from the electricity usage of the landfill gas extraction unit are now included. For the CO2 emission intensity of the grid a value of 0.987 t CO2e/MWh will be used. This is the value for a coal conventional steam power plant according to the EM model[5], The CEFs provided through the EM model are similar to those made available by the US Energy Information Agency (EIA). This is considered to be an conservative estimate given the fact in the validated PDD of the Santa Rosa hydro power project includes a CEF value of the Chilean grid of 0.476 t CO2e/MWh.

[5] Öko institute, 1998

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

No leakage effects have been identified. The applicable monitoring methodology does not require leakage to be accounted for.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

$$ER_y = (MD_{project,y} - MD_{reg,y}) * GDP_{CH4}$$

Where:

ER_y: greenhouse gas emission reduction achieved by the project activity during a given year "*y*" (t CO_2e).

$MD_{project,y}$: amount of methane actually destroyed/combusted during the year "*y*" (tCH_4).

$MD_{reg,y}$: amount of methane that would have been destroyed/combusted during the year *"y"* in the absence of the project activity (tCH_4).
GDP_{CH4}: approved Global Warming Potential value for methane (21 t CO_2e / tCH_4).

As the project will not include a thermal energy or electricity component, these factors will be excluded from the overall equation.

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

A (Indicate table and ID number e.g. D.4-1; D.4-2.)	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
1. LFG For MD $project_y$	Low	Yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy
2. LFG for MD $flared_y$	Low	Yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy
3 FE	Medium	Yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values.
4 $F_{CH4,y}$	Low	Yes	The gas analyser should be subject to a regular maintenance and testing regime to ensure accuracy.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The project monitoring will be conducted by Alfredo Gustavo Kother Feest, Mechanical Engineer of the Concepción University, Executive and Legal Representative of Group Machiels in Chile, Director of Copiulemu S. A..
To develop the project, Mr. Kother will count with the collaboration of the technical team of group Machiels in Chile, with more then 20 specialists in different areas of environmental activity.

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D.5 Name of person/entity determining the monitoring methodology:

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SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

The source of emissions from the project is the combustion of landfill gas, converting methane into CO2. As the methane is organic in nature these emissions are not counted as project emissions.

The emissions of the electricity consumption should be accounted as project emissions. By monitoring the electricity consumption of the gas extraction system and the CEF of Chile the emission can be determined. For now and estimate will be determined.

It is assumed that the electrical capacity of the gas extraction unit is 20 kW and that the load factor is 50%. A CEF of 1 kg/kWh is used. With these assumptions it can be calculated that the annual emission from the electricity consumption is 88 CERs.

E.2. Estimated leakage:

No leakage has been identified and needs to be accounted for by this methodology.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Not applicable.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

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 scenario. The equation is, as follows:

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

Where:

$MD_{reg,y}$: amount of methane that would have been destroyed/combusted during the year *"y"* in the
$MD_{project,y}$: amount of methane actually destroyed/combusted during the year *"y"* (tCH_4).
absence of the project activity (tCH_4).
AF = Adjustment Factor (%)

The methane destroyed by the project was estimated using the USEPA First Order Decay Model[6], using Lo and k values appropriate for the VIII region in Chile[7] and assuming that 85% of the landfill gas

[6] 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).

[7] Values chosen for Lo and k are confirmed in a report by the Inter American Development Bank. The value for k of 0.1 provided specifically for the VIII region in Chile (Región del Bíobío, where Copiulemu is located), and the

generated is collected by the gas collection system. In any case, as this projection is merely for illustrational purposes (i.e., the actual emissions reductions will be monitored directly).

The AF value used for this project is 17% (see section B.2 for the justification of this value). The value for AF will be revisited at the beginning of each crediting period and will be adjusted if affected by changes in national requirements or the Copiulemu permit.

The Table below shows the destruction of methane that would have taken place in the baseline scenario (MD_{reg}), using the equations described above and the US EPA model.

	Per year (average)	7 years	21 years
$MD_{project}$ (tCH_4)	5,176	36,230	166,610
AF (%)	17%	17%	17%[8]
MD_{reg} (tCH_4)	**880**	**6,159**	**28,324**

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

The consolidated methodology for landfill projects uses an equation for calculating the amount of methane destroyed in the project 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 project scenario. The equation is, as follows:

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

Where:

$MD_{project,y}$: amount of methane actually destroyed/combusted during the year *"y"* (tCH_4).
$MD_{flared,y}$: quantity of landfill gas flared during the year *"y"* (tCH_4).

The Table below shows the emissions reductions taking place in the project scenario ($MD_{project}$), using the equations described above and the US EPA model.

	Per year (average)	7 years	21 years
LFG_{flare} (m^3 LFG)	14,736,000	103,151,999	474,357,485
w_{CH4} (%)	50%	50%	50%

value for Lo of 2.63 is given for Chile as a whole (this is the standard value from the US EPA model, that is confirmed for Chile in this report). Banco Interamericano de Desarrollo, Informe de Avance, *Estudio de Políticas de Abatimiento de Gas de Efecto Invernadero y Desarrollo Económico: Sinergias y Desafíos para el caso de Chile*, Preparado por: Bitrán & Asociados Santiago, Mayo 2003.

[8] AF will be revised at the beginning of each crediting period.

D_{CH4} (t CH_4/m^3 CH_4)	0.0007168	0.0007168	0.0007168
FE (%)	98%	98%	98%
MDproject = MD_{flared} (tCH_4)	**5,176**	**36,230**	**166,610**

E.6. Table providing values obtained when applying formulae above:

The estimated results are presented in the following Table. The actual emission reductions generated by the project will be measured directly after the project is operational.

	Per year (average)	**7 years**	**21 years**
$MD_{project}$ (tCH_4)	5,176	36,230	166,610
MD_{reg} (tCH_4)	880	6,159	28,324
GWP_{CH4}	21	21	21
Electricity consumption emission	88	616	1,848
Electricity emissions reductions (tCO_2)	0	0	0
Emissions reduction generated by the project activity (ER, tCO_2e/year)	90,125	630,878	2,902,156

SECTION F. Environmental impacts

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

As required by Chilean legislation, during 1999 Copiulemu S. A. presented an Environmental Impact Study (EIS) to the 'Comision Nacional del Medio Ambiente' (CONAMA), VIII Region, the authority in charge to analyse projects with environmental impacts.

Copiulemu S.A. has received a positive resolution (permit) for his project, resolution N° 081, dated 09 March 2000.

Referring to gas control, it is stated in that resolution that a capture system is to be installed in the landfill, including two or three chimneys per hectare, for safety reasons in order to avoid explosions. With this approved installation, only a small percentage of the gas produced can be treated.

The environmental impact assessment is available at Copiulemu S.A. upon request.

By collecting and combusting landfill gas, the Copiulemu project will reduce both global and local environmental effects of uncontrolled releases. The major components of landfill gas, methane and carbon dioxide, are colorless and odorless. The main global environmental concern over these compounds is the fact that they are greenhouse gases. Although the majority of landfill gas emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of asphyxiation and/or toxic effects if landfill gas is present at high concentrations. Landfill gas also contains over 150 trace components that can cause other local and global environmental effects such as odor nuisances, stratospheric ozone layer depletion, and ground-level ozone creation. Through appropriate management of the site, landfill gas will be captured and combusted, removing the risks of toxic effects on the local community and local environment.

Combustion of landfill gas can also result in the release of organic compounds and trace amounts of toxic materials, including mercury and dioxins. These emissions are significantly less harmful than the continued uncontrolled release of landfill gas.

The project will have very limited effects regarding noise and visual amenity.

F.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. The Copiulemu project meets and goes beyond all permit requirements.

SECTION G. Stakeholders' comments

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

Letters were sent to the relevant authorities related with environmental activity. Political (executive and legislative) authorities, sanitary authorities and environmental authorities were informed about the project and asked to give their opinion.

A similar letter was also sent to the 'Federación Provincial de Uniones Comunales de Juntas de Vecinos de la Provincia de Concepción', that represents 11 communities in de province of Concepción.

An independent company (Cidem LTDA) was hired in order to develop an opinion poll in the nearest neighbourhoods to the Copiulemu landfill.

Copiulemu S.A. also put announcements in an important local newspaper in order to inform the public and to invite people to make comments and observations.

G.2. Summary of the comments received:

The reaction of the authorities is to support the development of the project, under Chilean and International legislation. Environmental Authorities recognise that this project is improving the original operational conditions, as authorised by the resolution of March 2000. Supporting letters where received from the 'federation of local communities', from a member of Chilean parliament, and from the commission of environment in the Bio Bio region (CONAMA).

The people in the neighbourhood of Copiulemu received the information positively.

No negative comments were received.

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

No negative comments were received, nor any other comments that should lead to any changes in the project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Empresa de Tratamiento de Residuos Copiulemu S.A.
Street/P.O.Box:	Calle B N° 1170
Building:	Lomas de San Sebastián
City:	Concepción
State/Region:	Region del Bio Bio (VIII Region)
Postfix/ZIP:	
Country:	Chile
Telephone:	0056 41 485011
FAX:	0056 41 485007
E-Mail:	
URL:	
Represented by:	Alfredo Kother Feest
Title:	General Manager Copiulemu
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	0056 41 485007
Direct tel:	0056 41 485011
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any public funding.

Annex 3

BASELINE INFORMATION

Inputs for baseline and emission reductions calculation.

INPUTS	
Year analysis was conducted	**2004**
LANDFILL DATA	List of countries
Country	**Chile**
Year started landfill operation	**2002**
Year finished operation	**2025**
Waste in place at beginning of project (tonnes)	**0**
R = Average daily waste rate (t/day)	**328.8**
Maximum flow of gas collected (m3/h)	**3,439**
Lo (cf/lb) =	**2.63**
k (1/year)=	**0.1**
Methane content of landfill gas=	**50%**
BASELINE DATA	
Residual emission factor CH4 to CO2	**0**
Proportion of methane flared in baseline (AF, %)	**17%**
PROJECT DATA	
Date gas collection project starts (year)	**2005**
Proportion of methane collected (%)	**85%**
Combustion effectiveness of Flare (%)	**98%**

Annex 4

MONITORING PLAN

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