Project design document form for CDM project activities

(Version 06.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Durban Landfill-gas-to-electricity project – Mariannhill and La Mercy Landfills
Version number of the PDD	4
Completion date of the PDD	30/06/2015
Project participant(s)	South Africa: Durban Solid Waste (DSW) - eThekwini municipality ; Netherlands: Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel S.A.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I); Finland: Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation; Germany: RWE Power AG; Japan: Chubu Electric Power Co., Inc; The Chugoku Electric Power Co., Inc.; Kyushu Electric Power Co., Inc.; Mitsubishi Corporation; Tohoku Electric Power Co., Inc.; The Tokyo Electric Power Co., Inc.; Shikoku Electric Power Co., Inc.; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd.; Norway: Government of Norway - Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA; United Kingdom of Great Britain and Northern Ireland: Deutsche Bank AG; BP Alternative Energy International Ltd; France: GDF SUEZ; Sweden: Government of Sweden - Swedish Energy Agency; Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)
Host Party	South Africa
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectoral Scopes: 13 (Waste Handling and Disposal) Methodology: ACM0001: Flaring or use of landfill gas, Version 15.0
Estimated amount of annual average GHG emission reductions	63,887 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The project, when originally registered, consisted of an enhanced collection of landfill gas at two landfill sites of the municipality of Durban, the use of the recovered gas to produce electricity and flaring of the excess gas. The electricity produced is fed into the South African grid system. In its first crediting period, the project was implemented on the Mariannhill and La Mercy landfill sites.

The Mariannhill landfill is an active landfill site where waste will be deposited until 2020. It extends over 49 ha and receives 550 to 850 tonnes of waste per day. To date, the site has received approximately 2,000,000 tonnes. The Mariannhill landfill was officially designated a Nature Conservancy site in late 2002. It is the only landfill in South Africa granted such a status. The second landfill site, La Mercy, was an old landfill, already closed and far away from residential areas. It was receiving around 350 tonnes of waste per day and it closed with about 1 million tonnes of waste in place.

During the first crediting period, the project implemented a landfill gas recovery system at La Mercy and substantially upgraded the collection system at Mariannhill where 6 wells were installed as a pilot activity prior to the implementation of the project activity. A low height enclosed flare with maximum capacity of 1,000 Nm^3/h and a 1MW electricity generation unit were installed at Mariannhill. Depending on gas availability, electricity generation may be subsequently augmented to up to 2MW of combined capacity. Meanwhile at the La Mercy site, due to the operational difficulties in extracting the landfill gas, the project activity did not continue extracting gas and was decommissioned on June 2009. A Notification of Changes (NoC) to the PDD was submitted and approved by CDM EB on its 65th meeting on 25/11/2011. Therefore, the project for the second and third crediting periods will focus on the gas extraction at the Mariannhill landfill.

The scenario existing prior to the implementation of the project activity was that neither landfill had an active landfill gas collection and utilization system in place. Landfill gas was vented to ensure that the concentration of methane in any particular area of the landfill stayed below hazardous levels. In the past, 6 collection wells were installed on the Mariannhill landfill as a pilot to investigate the feasibility of landfill gas recovery for electricity generation. The baseline scenario is the continuation of the practice prior to the implementation of the project, with limited collection and flaring of methane from the landfills in compliance with applicable regulations and the municipal electric company buying electricity from other suppliers. Therefore, the baseline scenario for the second crediting period is the same as the scenario existing prior to the implementation of the project activity.

The project activity contributes to sustainable development by improving the local environment with positive effects on air and groundwater quality. By displacing electricity from the grid, the project reduces emissions related to coal-fired power production which include sulphur oxides, nitrogen oxides, and particulates. It also reduces the adverse impacts related to transportation of coal and coal mining (dust and acid mine drainage). Near the landfill sites, the project improves the air quality by further reducing the amount of landfill gas released into the atmosphere and thus reducing the risk of exposure of neighbouring residents to odour. With regard to local employment, the project results in a small increase in the area of skilled jobs for operation and maintenance of the equipment.

It is estimated that the project will deliver an annual average emission reductions of **63,887tCO_2e** and total GHG emission reductions of **447,207 tCO_2e** for the second crediting period.

A.2. Location of project activity

A.2.1. Host Party

>>
South Africa.

A.2.2. Region/State/Province etc.

>>
KwaZulu Natal, South Africa

A.2.3. City/Town/Community etc.

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Municipality of eThekwini, formerly known as Durban

A.2.4. Physical/Geographical location

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The Mariannhill landfill site is located in the western area of the Durban city around 20 km to the west of Durban, in the Metro area formerly called the Inner West City Council (IWCC).

Durban is geographically located in the southeast region of South Africa on the Indian Ocean coast. The Mariannhill landfill site is located at Latitude: -29.846389, Longitude: 30.837778. The following figure provides details of the physical/geographical location of the project activity:

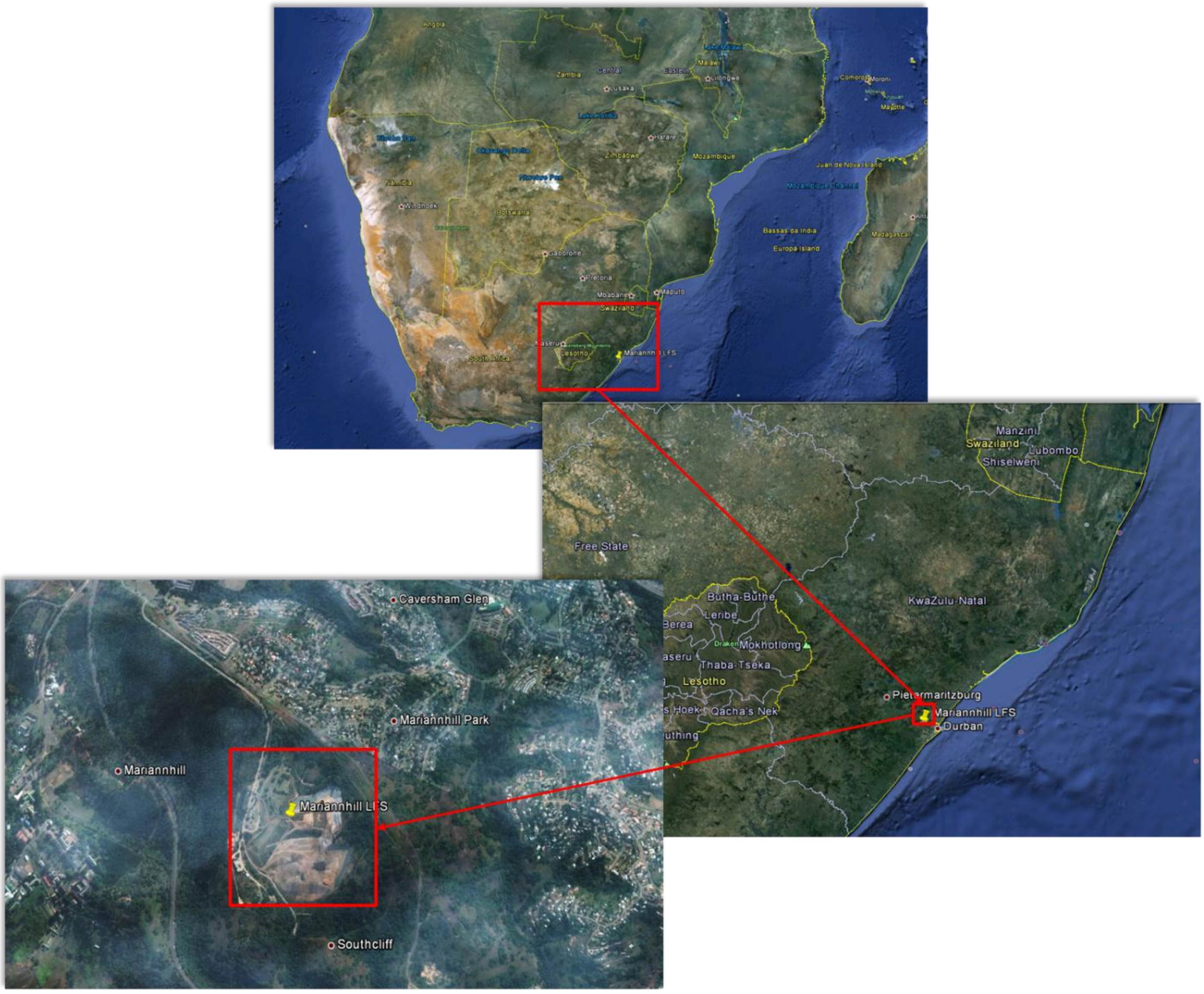

Figure 1. Physical/geographical location of the project activity

A.3. Technologies and/or measures

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During the first crediting period, the project involved the installation of a network of gas collection wells and pipework to which suction pressure is applied in order to draw landfill gas from the waste to undergo controlled combustion in a flare and to generate electricity by combustion in engines. The project implemented a substantial upgrade of a previously existing, small collection system at Mariannhill which comprised six gas collection wells installed as a pilot activity. Construction of the landfill gas management system began on 01/02/2006. The gas combustion equipment was commissioned in November 2006.

The gas utilisation system at Mariannhill currently comprises a 1MW Jenbacher 320 engine and low height enclosed flare. The network of gas collection wells has been expanded on a phased basis as the landfill site continues to develop.

Durban Solid Waste (DSW) is the municipal agency responsible for management and operation of multiple landfills in the Durban metropolitan area. Under the project, DSW has commissioned the installation of landfill gas extraction wells, flare units and landfill gas powered generators for the Mariannhill landfill site. DSW functions as the technical advisor and operator of the project. Specifically, the following technology has been installed:

- Extraction wells: gas wells will be constructed during phased restoration of the site to extract the landfill gas as it is produced.
- Gas collection pipework: Pipes collect and transport the gas from the wells to the extraction plant from where the gas is used for electricity generation, with any surplus gas being flared.
- Gas extraction plant (blower): A centrifugal blower is required to extract landfill gas from the wells and supply this to either the generation engine or the flare unit. The blower creates lower pressure inside the wells than in the landfill, thereby sucking the gas from the landfill into the wells and from there to the extraction plant.
- Flare unit: A low height enclosed landfill gas flare with maximum capacity of 1,000 Nm^3/h has been installed at the site.
- Landfill gas generator: A single 1MW unit has been installed at Mariannhill, which can be turned down to as low as 50% capacity (Jenbacher type 320 engine).
- Switchgears, transformers and cabling: have been installed as needed for interconnection with the eThekwini Electricity grid.
- Monitoring equipment: The monitoring system is based on the requirements specified by methodology ACM0001 “Flaring or use of landfill gas”, Version 15.0. Gas flow rates are recorded, along with methane content and electricity generation as the principal parameters which are used in the calculation of emission reductions. The site is equipped with a data logging system to capture all relevant performance data and maintain a database from which monthly summary reports can be easily extracted.

Prior to the project implementation there was no destruction and/or use of landfill gas from the landfill. The baseline scenario at the time of validation was the practice prior to the implementation of the project activity, which was the atmospheric release of the landfill gas and power generation using existing and/or new grid-connected power plants as identified in section B.4.

The construction of the project activity transferred technology and know-how to the Host Country. The technology employed by the project activity, in particular the LFG-fired electricity generator, was procured by a company in an Annex I country, and uses a renewable resource in order to generate electricity while emitting no greenhouse gases.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
South Africa (host)	Durban Solid Waste (DSW) - eThekwini Municipality	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM); Electrabel S.A.; Netherlands' Ministry of Economic Affairs, Agriculture and Innovation (EL&I);	Yes
Finland	Government of Finland - Ministry of Foreign Affairs of Finland; Fortum Corporation;	Yes
Germany	RWE Power AG	No
Japan	Chubu Electric Power Co. Inc; The Chugoku Electric Power Co. Inc; Kyushu Electric Power Co. Inc.; Mitsubishi Corporation; Tohoku Electric Power Co. Inc.; The Tokyo Electric Power Co. Inc.; Shikoku Electric Power Co. Inc; Japan International Cooperation Agency (JICA); Mitsui & Co. Ltd.	No
Norway	Government of Norway – Ministry of Foreign Affairs; Norsk Hydro ASA; Statoil ASA	Yes
United Kingdom of Great Britain and Northern Ireland	Deutsche Bank AG; BP Alternative Energy International Ltd	No
France	GDF SUEZ	No
Sweden	Government of Sweden - Swedish Energy Agency; International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)	Yes
Bilateral and Multilateral Funds	Prototype Carbon Fund Managing Company: International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)	-

The CDM-PDD for the second crediting period has been prepared by Sergi Cuadrat, in collaboration with Patricia Marcos Huidobro and Claudia Barrera from the Carbon Finance Unit of the World Bank.

A.5. Public funding of project activity

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The project has not received any public funding from Parties included in Annex I of the UNFCCC.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

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As per paragraph 230 (b) of the "Clean Development Mechanism Project Standard", version 05.0, if a baseline and monitoring methodology, applied in the original CDM-PDD, was withdrawn after the registration of the CDM project activity and replaced by a consolidated methodology, the latest approved version of the respective consolidated methodology shall be used. The CDM-PDD corresponding to the first crediting period for the "Durban Landfill-Gas-to-Electricity Project – Mariannhill and La Mercy Landfills" applied the baseline and monitoring methodology AM0010: "Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law" Version 01. This methodology has been replaced by the consolidated methodology ACM0001, "Flaring or use of landfill gas" (version 15.0).

- Therefore the approved baseline and monitoring methodology applied for the second crediting period for the project activity is ACM0001, "Flaring or use of landfill gas" (version 15.0). In accordance with the methodology, the project makes use of the latest versions of the following tools:"Emissions from solid waste disposal sites" (version 06.0.1)
- "Project emissions from flaring" (version 02.0.0)
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1)
- Standardized baseline "Grid emission factor for the Southern African power pool", (version 01.0)
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0)
- "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)

The methodology and methodological tools listed above are available at the following website: http://cdm.unfccc.int/methodologies/DB/EYUD9R1ZAUZ2XNZXD3HQH18OK3VWIV

B.2. Applicability of methodology and standardized baseline

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Methodology ACM0001 "Flaring or use of landfill gas" (version 15.0) is applicable to project activities which:

(a) Install a new LFG capture system in a new or existing SWDS where no LFG capture system was installed prior to the implementation of the project activity; or

(b) Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:

(i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and

(ii) In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.

(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:

  (i) Generating electricity;

  (ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace;[1] and/or

  (iii) Supplying the LFG to consumers through a natural gas distribution network.

(d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.

The following paragraphs describe how each of the applicability conditions of the methodology ACM0001 "Flaring or use of landfill gas" (version 15.0) are met by the project activity:

(a) At the validation of the project activity, the South African Department of Water Affairs & Forestry (DWAF), under the “Minimum Requirements for Waste Disposal by Landfill” (3rd Edition, 2005) required all landfill operators to monitor CO_2 and CH_4 concentrations, although it did not specify the landfill gas capture to be installed . The DWAF specified the requirements for landfill operators as follows:

“The Permit Holder shall implement adequate measures to the satisfaction of the Regional Director, to ventilate or to prevent lateral migration of CH_4 gas generated in the site so that build-up of dangerous concentrations is prevented. The concentration of flammable gas outside the waste disposal area and inside the Site shall not exceed 1% by volume in air and the concentration of CO_2 should not exceed 0.5% by volume in air, amended for Standard Temperature and Pressure.”

Prior to the implementation of the project activity, the LFG was mostly vented to the atmosphere because the landfill only included six gas passive collection wells as a gas pumping[2] trials to investigate the possibility to extract the gas from the landfill. Under such minimum requirements in South Africa, gas monitoring at the surface of all hazardous and large landfills was required, reporting to the department if the concentration of soil gas exceeded 1%, and permanent venting systems if the methane concentration exceeded 5% in air according to the “Minimum Requirements for Waste Disposal by Landfill”, (published in 2005 and constituting the most recent legislation on landfill site management available in South Africa at the time of validation).

At the time of the renewal of the crediting period, the new waste management legal regime in South Africa is delimited by the National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA)[3], which was assented on 06/03/2009 as a regulation (NEM: WA Regulations). The NEM: WA does not introduce into South African legislation the requirement for landfill gas to be captured and flared[4].

Since the landfill gas capture was not mandated by law prior to the implementation of the project activity (and it is not mandated neither at the time of the renewal of the crediting period under the new regulation), the project activity, implied by the installation of a new LFG capture system in the existing SWDS, meets the methodology requirements by corresponding to the applicability criteria (a) set above.

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[1] For claiming emission reductions for other heat generation equipment (including other products in kilns), project participants may submit a revision to this methodology.

[2] Gas pumping trials: Test wells used to estimate the gas production within a new site. “Landfill Gas Industry Code of Practice”, March 2012. Available at http://www.esauk.org/reports_press_releases/esa_reports/LandfillgasICoP2012web.pdf

[3] National Environmental Management: Waste Act No. 59 of 2008. Available at http://www.info.gov.za/view/DownloadFileAction?id=97351

[4] See letter provided to the DOE under the name “SA Landfills Legal Requirements April 2013” from ENS as a law firm confirming the situation.

(b) Although there was a passive LFG capture system at Mariannhill site with only six wells to investigate the possibility to extract the gas from the landfill, an investment into such existing LFG capture system was made to increase the recovery rates and therefore applicability criteria (b) set above is met by the project activity because:

   (i) The LFG was only vented at Mariannhill site and not flared, neither used prior to the implementation of the project activity. Since the project activity will capture the LFG to be flared or used, the applicability criteria (b) (i) is applicable to the project activity at the Mariannhill site.

   (ii) The LFG capture system in place at the Mariannhill site with only six wells was a passive system so there was not an existing active LFG capture system in place. Therefore, applicability criterion (b) (ii) is applicable to the project activity at the Mariannhill site.

(c) The project activity at the Mariannhill site flares the LFG and/or uses the captured LFG as follows:

   (i) The project activity at Mariannhill generates electricity so the applicability criterion (c) (i) is applicable to the project activity.

   (ii) The project activity at Mariannhill will not use the captured LFG to generate heat in a boiler, air heater nor kiln (brick firing only) so the applicability criterion (c) (ii) is not applicable to the project activity.

   (iii) The project activity at Mariannhill will not supply the LFG to consumers through a natural gas distribution network so the applicability criterion (c) (iii) is not applicable to the project activity.

   (iv) The project activity at Mariannhill will not supply compressed/liquefied LFG to consumers using trucks so the applicability criterion (c) (iv) it not applicable to the project activity.

(d) The waste entering to the landfill is not managed through recycling; it is landfilled as it arrives to the landfill. Therefore, the project will not have any effect on the waste entering to the landfill. The project activity at Mariannhill will not reduce the amount of organic waste that would have been recycled in the absence of the project activity so the project meets the applicability criterion (d).

Moreover, methodology ACM0001 "Flaring or use of landfill gas"(version 15.0) is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:

(a) Atmospheric release of LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and

(b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln;

   (i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or

   (ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.

Prior to the project implementation, as identified in Section B.4, there was no destruction and/or use of landfill gas from the landfill. The baseline scenario at the time of validation was the practice prior to the implementation of the project activity, which was the atmospheric release of LFG from the SWDS (so the project met the applicability criterion (a) above) and power generation using existing and/or new grid-connected power plants (meeting the applicability criterion (b) (i) above).

For the second crediting period of the project activity, as can be shown in Section B.4. of this document, the continued validity of the original baseline has been assessed as per the tool

"Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1) by following the stepwise procedure.

Finally, methodology ACM0001 "Flaring or use of landfill gas" (version 15.0) is not applied to this project activity:

(a) In combination with other approved methodologies. The purpose of the CDM project activity is not to implement energy efficiency measures at the kiln. Since condition (a) is not applicable to the project activity, ACM0001 "Flaring or use of landfill gas" (version 15.0) is applicable for the project activity.

(b) If there is a change of the management of the SWDS in order to increase methane generation compared to the situation prior to the implementation of the project activity. Since condition (b) is not applicable to the project activity, ACM0001 "Flaring or use of landfill gas" (version 15.0) is applicable for the project activity.

The following paragraphs describe how each of the applicability conditions of the latest versions of the tools, are met by the project activity:

- "Emissions from solid waste disposal sites" (version 06.0.1) is applicable for waste disposal sites where the waste would be dumped and can be clearly identified. For the case of the project activity it is clearly identified at the Mariannhill Landfill site. The second applicability condition states that the tool is not applicable to hazardous wastes, and at the project site there are no hazardous wastes, thus the project activity also meets the tool's applicability conditions.

- "Project emissions from flaring" (version 02.0.0) is used to determine $PE_{flare,y}$ as required by methodology ACM0001 "Flaring or use of landfill gas" (version 15.0).

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) is applicable for the purpose of calculating project emissions when a project activity consumes electricity from the grid (Scenario A of Section I of the Tool). For the project activity, since electricity will be sourced from the grid, the tool is applicable.

- The standardized baseline "Grid emission factor for the Southern African power pool" is applicable for the purpose of calculating project and leakage emissions when the project activity consumes electricity from the grid or results in increase of consumption of electricity from the grid outside the project boundary. For the current project activity, since electricity will be sourced from the grid, the standardized baseline is applicable.

- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0) is applicable for the purpose of determining the mass flow of greenhouse gases such CO_2, CH_4, N_2O, SF_6 or PFC. The mass flow of a particular greenhouse gas is calculated based on measurements of: (a) the total volume flow or mass flow of the gas stream, (b) the volumetric fraction of the gas in the gas stream and (c) the gas composition and water content. Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions, which is the case of this project activity, then the tool is applicable.

- "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1) provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period, as required by paragraph 49 (a) of the modalities and procedures of the clean development mechanism.

B.3. Project boundary

As per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0), the project boundary of the project activity shall include the site where the LFG is captured and where the LFG is flared or used (in this case flared, and used by the power plant);

The sources and gases included in the project activity are indicated as follows:

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the SWDS site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project scenario	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from electricity consumption due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small

In addition to the table, a flow diagram of the project boundary, physically delineating the project activity is presented below, based on the description provided in section A.3 above. The flow diagram presents the equipment, systems and flows of mass and energy described in that section. In particular, it is indicated in the diagram the emission sources and GHGs included in the project boundary and the data and parameters to be monitored taking into account the project boundary as per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0), as follows:

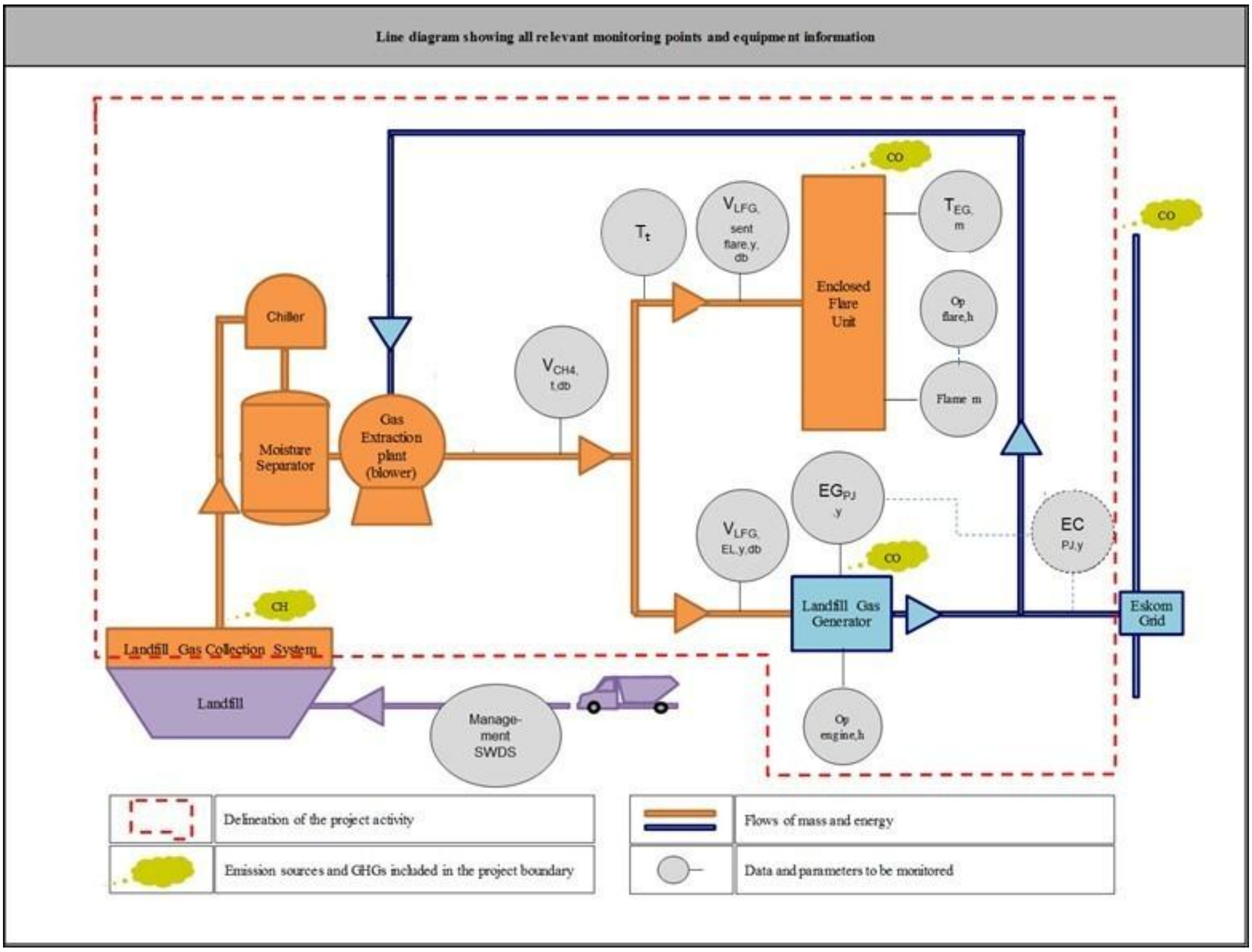

Figure 2. Flow diagram of the project boundary

B.4. Establishment and description of baseline scenario

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As per paragraph 230 (b) of the "Clean Development Mechanism Project Standard", version 05.0, if a baseline and monitoring methodology, applied in the original CDM-PDD, was withdrawn after the registration of the CDM project activity and replaced by a consolidated methodology, the latest approved version of the respective consolidated methodology shall be used. The CDM-PDD corresponding to the first crediting period for the "Durban Landfill-Gas-to-Electricity Project – Mariannhill and La Mercy Landfills" applied the baseline and monitoring methodology AM0010: "Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law" Version 01, which was then replaced by the consolidated methodology ACM0001, "Flaring or use of landfill gas" (version 15.0), and therefore used in the current version of the CDM-PDD.

Additionally, as per paragraph 231 of the "Clean Development Mechanism Project Standard", version 05.0, the demonstration of the validity of the original baseline or its update does not require a reassessment of the baseline scenario, but rather an assessment of the emissions which would have resulted from that scenario.

As required by paragraph 49 (a) of the modalities and procedures of the Clean Development Mechanism, at the start of the second and third crediting period, project proponents have to assess the continued validity of the baseline and to update if necessary the baseline at the renewal of a crediting period. To do so, the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1) consists of two steps:

- The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period.
- The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.

For the second crediting period of the project activity, the continued validity of the original baseline has been assessed as per the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1), following the stepwise procedure as shown below:

Step 1: Assess the validity of the current baseline for the next crediting period

The "Clean Development Mechanism Project Standard", version 05.0, approved by the CDM Executive Board requires assessing the impact of new relevant national and/or sectoral policies and circumstances on the baseline. The validity of the current baseline is assessed using the following Sub-steps:

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

At the time when the project activity at Mariannhill site was submitted for validation, (registered on 15/12/2006), the "Minimum Requirements for Waste Disposal by Landfill" (3rd Edition, 2005)[5] legislation issued by the South African Department of Water Affairs & Forestry (DWAF) was applicable. The legislation required all landfill operators to monitor CO_2 and CH_4 concentrations at the surface, although it did not specify the landfill gas capture to be installed. Therefore, the legislation applicable at the submission for validation of the project activity did not require landfills to collect nor utilize the gas generated hence it was not mandated by regulations.

At the time of the renewal of the crediting period, the new waste management legal regime in South Africa is delimited by the National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA)[6], which was assented on 06/03/2009 as a regulation (NEM: WA Regulations). The NEM: WA does not introduce into South African legislation the requirement for landfill gas to be captured and flared[7]. Therefore, the project participant is still not required to capture and flare LFG at the start of the second crediting period by any mandatory law.

Since the landfill gas capture was not mandated by law prior to the implementation of the project activity (and it is still not mandated at the time of the renewal of the crediting period under the new regulation), the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation and are applicable at the time of requesting renewal of the crediting period.

As per the tool, given that the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation or the submission of the previous request for renewal of the crediting period and are applicable at the time of requesting renewal of the crediting period, then we shall move to Step 1.2.

Outcome of step 1.1: Since the current baseline complies with all relevant mandatory national and/or sectoral policies, Step 1.2 is followed.

Step 1.2: Assess the impact of circumstances

Following the tool, and given that the baseline scenario identified at the time of validation of the project activity was the continuation of the practice prior to the implementation of the project activity without any investment, (i.e. is continuation of the practice at the time with limited collection and flaring of methane from the landfills), then an assessment of the changes in market characteristics has been conducted.

[5] http://www.dwaf.gov.za/Documents/Other/WQM/RequirementsWasteDisposalLandfillSep05Part1.pdf

[6] National Environmental Management: Waste Act No. 59 of 2008. Available at http://www.info.gov.za/view/DownloadFileAction?id=97351

[7] See letter provided to the DOE under the name "SA Landfills Legal Requirements April 2013"from ENS as a law firm confirming the situation.

Since the registration of the project activity landfill gas management in South Africa continues to be limited to passive venting of gas, as stated in the report "Minimum Requirements for Waste Disposal by landfill" published in 2005 by the Department of Water Affairs and Forestry[8]. As indicated by the report, the prevailing practice in South Africa is either to vent LFG to ensure that the concentration of methane in any particular area of the landfill remains below hazardous levels, or not to install any kind of management and capturing system.

The Department of Minerals and Energy of South Africa conducted a detailed study for assessment of potential landfill gas capture and utilization sites in the country as part of their Capacity Building in Energy efficiency and renewable energy initiative. The study "Landfill Gas Resources for Power Generation in South Africa"[9] identified 453 landfill sites under operation or in the process of being given a permit out of which only 57 had sufficient waste input to justify investigation as potential landfill gas-to-power projects (these have been characterized as micro, small, medium and large landfills). Further, although 57 sites have the potential to be a power generation project, in reality power generation opportunities are only associated with an estimated 20 landfill sites: the largest ones located in metropolitan or municipal areas (meaning excluding those that had been identified as micro landfills).

The following table contains a list of 22 landfills in South Africa which are registered as CDM projects or have submitted a Project Idea Note to South Africa DNA for approval[10].

#	Project Title	Project Description	Project Status
1	Durban Landfill-gas-to-electricity project – Marianhill and La Mercy Landfills	LFG Utilization / Flaring	Registered
2	EnviroServ Chloorkop Landfill Gas Recovery Project	LFG Utilization / Flaring	Registered
3	Durban Landfill gas to Electricity Project – Bisasar Road Landfill	LFG Utilization / Flaring	Registered
4	Ekurhuleni Landfill gas Recovery Project	LFG Utilization / Flaring	Registered
5	Alton Landfill Gas to Electricity project	LFG Utilization / Flaring	Registered
6	New England Landfill Gas to Energy Project	LFG Utilization / Flaring	Approved by the DNA
7	Nelson Mandela Bay Metropolitan's Landfill Gas Project	LFG Utilization / Flaring	Registered
8	Joburg Landfill Gas to Energy Project	LFG Utilization / Flaring	Registered
9	Landfill Gas utilization programme of South Africa	LFG Utilization / Flaring	Approved by the DNA
10	City of Cape Town Landfill Gas Extraction And Utilization Programme of Activities (PoA).	LFG Utilization / Flaring	Approved by the DNA
11	Tshwane-Lilanda Methane Gas Project	LFG Utilization / Flaring	Approved by the DNA
12	The Bulbul drive landfill gas electricity generation project	LFG Utilization / Flaring	Approved by the DNA
13	The Buffalo City Landfill Gas to Electricity	LFG Utilization /	Approved by the DNA

[8] It is to be noted that these minimum requirements have not yet been enforced by the government. Department of Water Affairs and Forestry, 2005: Minimum requirements for waste disposal by landfill, 3rd edition, Chapter 8.4.6 Gas management systems, p. 99, available at: http://www.gkit.co.za/legislation/RequirementsWasteDisposalLandfillSep05Full.pdf

[9] Capacity Building in Energy Efficiency and Renewable Energy: Landfill Gas Resources for Power Generation in South Africa, Department of Minerals and Energy Pretoria - http://www.nano.co.za/FinEconCalcREStratFormApr04FinalReport.pdf

[10] http://www.energy.gov.za/files/esources/kyoto/2013/South%20African%20CDM%20Projects%20Portfolio%20up%2021%20February%202013.pdf

	Clean Developemt Mechanism project	Flaring	
14	Belville Landfill Gas Project	LFG Flaring	Approved by the DNA
15	Coastal Park Landfill Gas Project	LFG Flaring	Approved by the DNA
16	Vissershok Landfill Gas Project	LFG Flaring	Approved by the DNA
17	Faure and Swartklip Landfill Gas Project	LFG Flaring	Approved by the DNA
18	Boitshepi Landfill Gas Project		
19	Waldrift Landfill Gas Project	LFG Utilization / Flaring	Approved by the DNA
20	Ga-Rankuwa and Soshanguve Landfill Gas to Energy Project	LFG Utilization / Flaring	Approved by the DNA
21	Hatherley and Kwaggasrand Landfill Gas to Energy Project	LFG Utilization / Flaring	Approved by the DNA
22	Gartskloof and Onderstepoort Landfill Gas to Energy Project	LFG Utilization / Flaring	Approved by the DNA

Therefore, as can be seen from the table above, and based on the analysis conducted by the Department of Water Affairs and Forestry, those landfill sites that had been identified as having the potential to generate energy have followed the registered landfill sites and are being developed under the CDM. Therefore, the market conditions for landfill gas collection and use outside of the CDM, continue to be the same as when the project was first presented for validation. Without the expectations coming from the CDM revenues, there is no real incentive for landfill sites to implement this type of technology.

In addition, since there have not been any updates that have come into effect after the submission of the project activity for validation with respect of the requirement to capture and flare LFG at the start of the second crediting period by any mandatory law, then the conditions used to determine the baseline emissions in the previous crediting period are still valid.

As for the availability of new fuels or raw materials, it should be noted that the implementation of a fossil fuel fired or renewable based cogeneration plant is very unlikely as there is no demand for heat around the project location. In addition fossil fuel fired or renewable based captive power plants are not credible and realistic alternatives due to the high costs and the unavailability of renewable resources such as hydro or biomass at the project location. The solar photovoltaic technology is not financially affordable for the project owner. Therefore, the baseline alternative of electricity generation is to produce equivalent amount of electricity by grid-connected power plants located throughout South Africa.

In summary, the new market conditions, as well as the prevailing practice and the availability of alternative technologies to generate energy, continue to be the same as those that applied for the first crediting period.

Outcome of step 1.2: Given that the new circumstances provide a continued validity of the current baseline, then the current baseline does not need to be updated for the subsequent crediting period.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

As per the tool, this sub-step should only be applied if the baseline scenario identified at the time of validation of the project activity was the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology. Therefore, this step is not applicable to this project activity because that was not the baseline scenario identified for this project activity: there was no running equipment at the time and no investment was to be undertaken later on.

Outcome of step 1.3: Since the baseline scenario identified at the time of validation of the project activity was not the continuation of use of the current equipment(s), this step is not applicable.

Step 1.4: Assessment of the validity of the data and parameters

Under this step, the tool indicates that data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period should be assessed to determine if they are still valid or whether they should be updated. Updates should be undertaken in the following cases:

- Where IPCC default values are used, the values should be updated if any new default values have been adopted and published by the IPCC, for example, in guidelines for national GHG inventories, IPCC assessment report or special reports by the IPCC;
- Where emission factors, values or emission benchmarks are used and determined only once for the crediting period, they should be updated, except if the emission factors, values or emission benchmarks are based on the historical situation at the site of the project activity prior to the implementation of the project and cannot be updated because the historical situation does not exist anymore as a result of the CDM project activity.

In order to estimate emission reductions ex ante in the previous crediting period at the Mariannhil, landfill gas generation was simulated using the GasSim model. The GasSim model uses information on waste composition and quantity, landfill engineering, and landfill gas management techniques to enable assessment of the best combination of control measures for a particular design and rate of filling. At that time, the methodology AM0010 “Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law” – Version 01, did not have an explicit set of data and parameters to be determined at the start of the crediting period. For the renewal of the crediting period, the approved baseline and monitoring methodology used is ACM0001 "Flaring or use of landfill gas" (version 15.0), which makes use of the latest version of the tool "Emissions from solid waste disposal sites" (version 06.0.1) which requires data and parameters that are different from the ones required by the GasSim model.

Outcome of step 1.4: Since data and parameters that were only determined at the start of the crediting period and not monitored during the crediting period are not valid anymore because the calculation method has changed, the current baseline needs to be updated for the subsequent crediting period.

The application of Steps 1.1, 1.2, 1.3 and 1.4 confirmed that the current baseline as well as data and parameters are not valid for the subsequent crediting period, therefore we proceed to Step 2.

Step 2: Update the current baseline and the data and parameters

Step 2.1: Update the current baseline

Following the tool, the baseline emissions for the second crediting period have been updated, without reassessing the baseline scenario, as per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0). This update was applied in the context of the sectoral policies and circumstances that are applicable at the time of requesting the renewal of the crediting period. More details for the updated baseline emissions for the second crediting period can be seen in section B.6.

Step 2.2: Update the data and parameters

As mentioned on step 1.4 above the data and/or parameter(s) that were determined at the start of the crediting period and not monitored during the crediting period are not valid anymore, therefore all applicable data and parameters have been updated, following the guidance in Step 1.4 and as per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0).

B.5. Demonstration of additionality

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As per paragraph 230 of the "Clean Development Mechanism Project Standard", version 05.0, for the preparation of a revised PDD "Project participants shall update those sections of the project design document (CDMPDD) relating to the *baseline*, *estimated emission reductions* and the *monitoring plan* using an approved baseline and monitoring methodology"; therefore section B.5 on demonstration of additionality remains the same as that for the registered CDM-PDD corresponding to the first crediting period.

In the registered CDM-PDD corresponding to the first crediting period applying AM0010 "Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law" – Version 01, it was demonstrated that the cost of the electricity generated by the project activity was higher than the long run marginal cost LRMC. It was assumed that generation by the grid (the baseline scenario) was financially more attractive than generation by the project. Furthermore, with the removal of the La Mercy site from the project activity, on the approved version 5 of the PDD dated 05/03/2012 it was also demonstrated that the cost of the electricity generated by the project activity was still higher than the long run marginal cost. It was therefore concluded that the project was additional and as per paragraph 230 of the "Clean Development Mechanism Project Standard", version 05.0, additionality remains the same for the second crediting period.

In the below paragraphs, the baseline scenario for the Mariannhill landfill is determined following the four steps outlined in AM0010 (methodology applied for the first crediting period).

Step 1: Provide a convincing justification that there is no plausible baseline scenario except the project and the business as usual (BAU) scenario. If there is another plausible baseline scenario, this methodology cannot be used for the proposed project activity. The justification of the baseline scenario shall take into account whether national or local regulations require capture of landfill gas.

For Durban, several scenarios were identified as possible future developments, namely:
(a) Business-as-usual (BAU): Currently, neither landfill has an active landfill gas collection and utilization system in place. Landfill gas is currently vented to ensure that the concentration of methane in any particular area of the landfill stays below hazardous levels. In the past, 6 collection wells were installed on the Mariannhill landfill as a pilot to investigate the feasibility of landfill gas recovery for electricity generation. However, as it turned out that this option was uneconomical, DSW has abandoned all further activities. The BAU scenario is the continuation of passive venting at both sites and the operation of 6 test wells with declining efficiency; (b) The proposed project: collection of most landfill gas, its use for municipal power generation on the landfill site, and an equivalent reduction in power purchases from Eskom and (c) Collection and flaring of most of the landfill gas without use of the gas for power generation.

Existing landfilling capacity, cost considerations and regulatory requirements governing waste management were identified as the key factors that influence the realization of the above scenarios. Based on these factors, scenario (c) was rejected as an implausible baseline alternative.

Currently no collection and flaring are required by South Africas waste management regulations. The installation of a gas collection and flaring system in excess of current practice and legal requirements would result in unnecessary costs without associated income (or cost savings) to offset these costs.
The South African Department of Water Affairs & Forestry (DWAF) requires all landfill operators to monitor CO_2 and CH_4 concentrations. The DWAF specifies the requirements for landfill operators as follows:

"The Permit Holder shall implement adequate measures to the satisfaction of the Regional Director, to ventilate or to prevent lateral migration of CH_4 gas generated in the site so that build up of dangerous concentrations is prevented. The concentration of flammable gas outside the waste disposal area and inside

the Site shall not exceed 1% by volume in air and the concentration of CO_2 should not exceed 0.5% by volume in air, amended for Standard Temperature and Pressure." (from Landfill Permit Requirements)

The minimum requirements for waste disposal by landfill in South Africa include gas monitoring at all hazardous and large landfills, reporting to the department if the concentration of soil gas exceeds 1%, and permanent venting systems if the methane concentration exceeds 5% in air (per Minimum Requirements for Waste Disposal by Landfill, Second Edition 1998).

In the past, the environmental standards for landfills have been tightened on average every four years with the last revision dating back to 1998. New Revised DWAF Minimum Requirements were issued on 21st October 2005. The revised DWAF requirements do not require gas capture and flaring from permit holders, given the high costs that such a requirement would incur on landfill operators. The Bisasar Road, Mariannhill and Durban Bulbul Drive landfills were the only landfill sites in South Africa which have installed limited gas flaring systems at the time of project registration. Rather, ongoing discussions indicate that the upcoming revision of the permit requirements will loosen the acceptable standard for CO_2 concentration.

Mariannhill landfill is operating in compliance with the mandatory requirements. In the absence of further regulatory or economic incentives to collect and destroy landfill gas, the plausible baseline alternatives are reduced to the project and the BAU scenario.

Step 2: Calculate the cost of a kWh of electricity generated by the project using conservative assumptions. The calculation must include the incremental investment cost, the operations and maintenance costs, and all other costs of upgrading the BAU scenario to the proposed project activity. Assumptions are conservative if they tend to reduce the cost of the electricity generated. Conservatism of the assumptions should be ensured by obtaining expert opinions and by the Operational Entity validating the project.

The expected cost of electricity generation by the project is calculated at US$ 0.0422 per kWh.

After the decommissioning of the La Mercy site, and as per the guidelines on EB48, Annex 66 and 67, a conservative reassessment was done for the expected cost of electricity generation only by the Mariannhill landfill site. Under this consideration two analyses were made: 1-Isolating Mariannhill site under exactly the same assumptions as the original analysis, and 2-Isolating Mariannhill site and updating the actual energy generation capacity installed and the number of wells.

The result under both analyses was: US$ 0.0476 per kWh and US$ 0.0377 per kWh respectively.

Step 3: Determine the long run marginal cost (LRMC) of continued electricity generation by the grid. The LRMC is expressed as a cost per kWh. To be conservative, assumptions used to calculate the LRMC should increase the cost per kWh.

Until the end of the projects first crediting period in 2012, the LRMC of electricity generation by the grid are conservatively estimated at US$ 0.0225 per kWh. Over the project lifetime, the LRMC are expected not to exceed US$ 0.0365 per kWh.

Step 4: Demonstrate that the cost of the electricity generated by the project (*Step 2*) is higher than the LRMC (*Step 3*). If that is the case, it can be assumed that generation by the grid (the baseline scenario) is financially more attractive than generation by the project and that the project is additional.

Based on low power purchase prices and using the equally low LRMC for power production in South Africa as an approximation of future electricity prices charged to communities, it is concluded that, from an investment point of view, the auto-generation option using the landfill gas is not an economically attractive course of action for the municipality now or in any foreseeable

future. The same holds true for the analysis carried out after the decommissioning of the La Mercy site, and with the current configuration of the Mariannhill site up to 2011; the same will also hold true with further installation of wells, as the project will become even less economically attractive.

The baseline scenario, as determined above, is the continuation of the current practice of limited collection and flaring of methane from the landfills in compliance with applicable regulations. Given the long-run calculation performed in the baseline study, the BAU baseline is likely to be valid for the duration of the 21-year crediting period selected for this project. However, the BAU baseline includes the possibility that future South African waste management regulations will require the treatment of landfill gas, in which case the baseline scenario would have to reflect such new obligations. The baseline scenario therefore incorporates regulatory changes that would require a change in the current, business-as-usual operation of the landfill sites. The project will monitor any regulatory changes that impact waste management in South Africa and will adjust the baseline scenario by re-designating some landfill gas project wells to baseline wells.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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The following formulae will be followed by the project as per methodology ACM0001 "Flaring or use of landfill gas" (version 15.0).

Baseline emissions

Baseline emissions are determined according to equation 1 and comprise the following sources:

(A) Methane emissions from the SWDS in the absence of the project activity;

(B) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

(C) Heat generation using fossil fuels in the absence of the project activity; and

(D) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

Step A: Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and

destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:[11]

$$BE_{CH4,y} = (1 - OX_{top\_layer}) \times (F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4} \quad \textbf{(2)}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

Step A.1: Ex post determination of $F_{CH4,PJ,y}$

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution network, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(3)}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (t CH_4/yr)
$F_{CH4,HG,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* (t CH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (t CH_4/yr)

Since the project activity includes neither heat generation nor use of landfill gas as natural gas, the Equation (3) above can be simplified to:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$

Simplification of Equation (3) of ACM0001 (version 15.0)

The working hours of the power plant(s) and flare(s) should be monitored and no emission reduction should be claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{engine,h,y}$ and $Op_{flare,h,y}$).

[11] $OX_{top-layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool “Emissions from solid waste disposal sites”. In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

$F_{CH4,flared,y}$ and $F_{CH4,EL,y}$ are determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0. The following requirements apply:

- The gaseous stream the tool shall be applied to the LFG delivery pipeline to each item of electricity generation or heat generation equipment *j*, or the natural gas distribution system. $F_{CH4,EL,y}$ and $F_{CH4,HG,y}$ are then calculated as the sum of mass flows to each item of electricity generation or heat generation equipment *j*;
- CH_4 is the greenhouse gas for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool);
- The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;
- The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

$F_{CH4,flared,y}$ and $F_{CH4,EL,y}$ are determined ex post as per the following procedures a) and b), respectively:

(a) Amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \quad \textbf{(4)}$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,sent\ flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

The amount of methane in the LFG which is destroyed by flaring in year y ($F_{CH4,sent\_flare,y}$) will be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0, applying the requirements described above where the gaseous stream is the LFG delivered to the flare(s). The Option 2 of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0 under the name “Simplified calculation without measurement of the moisture content” will be applied as a simple and conservative approach to determine the absolute humidity of the gaseous stream of $F_{CH4,sent\_flare,y}$ by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Since the gaseous stream flow will be measured on volume basis and the volumetric fraction of methane will be measured in dry basis, two options will be used in the project activity:

- Option A will be used in case of dry basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point (way b of Option A), and
- Option B will be used in case of wet basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is more than 60ºC (333.15 K) at the flow measurement point and by converting the measured volumetric flow from wet basis to dry basis.

$PE_{flare,y}$ shall be determined using the methodological tool “Project emissions from flaring” version 02.0.0. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

Project emissions from flaring will be calculated and monitored according to the procedures described in “Project emissions from flaring” version.2.0.0. Default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option A of “Project emissions from flaring” version 02.0.0. The flare height installed in the project activity is less than ten (10) times the diameter. This makes it a low height flare. As per the tool “Project emissions from flaring” version 02.0.0, a low height flare is an enclosed flare for which the flame enclosure has a height between ten (10) and two (2) times the diameter of the enclosure. Given that the project is using a low height flare, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 80% will be used for the project activity.

The following steps will be applied ex-post to calculate the methane destruction efficiency of the flare:

Project emissions from flaring, version 2.0.0.

STEP 1: Determination of the methane mass flow in the residual gas

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0 shall be used to determine the following parameter:

Variable	***Description***
$F_{CH4,m}$	Mass flow of methane in the residual gaseous stream in the minute *m* (kg)

The mass flow of methane in the residual gaseous stream in the minute m (kg) ($F_{CH4,m}$) will be determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0, applying the requirements described above where the gaseous stream is the LFG delivered to the flare. The Option 2 of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” version 2.0.0 under the name “Simplified calculation without measurement of the moisture content” will be applied as a simple and conservative approach to determine the absolute humidity of the gaseous stream of $F_{CH4,m}$, by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Since the gaseous stream flow will be measured on volume basis and the volumetric fraction of methane will be measured in dry basis, two options will be used in the project activity:

- Option A will be used in case of dry basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point (way b of Option A), and
- Option B will be used in case of wet basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is more than 60ºC (333.15 K) at the flow measurement point and by converting the measured volumetric flow from wet basis to dry basis.

The following requirements apply:

- The gaseous stream tool shall be applied to the residual gas;
- The flow of the gaseous stream shall be measured continuously;
- CH_4 is the greenhouse gas *i* for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and

The time interval t for which mass flow should be calculated is every minute *m*.

STEP 2: Determination of flare efficiency

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. The project activity has installed an enclosed flare.

Enclosed flare

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute *m* ($\eta_{flare,m}$) and shall document in the CDM-PDD which option is selected:

Option A: Apply a default value for flare efficiency.
Option B: Measure the flare efficiency.

For enclosed flares that are defined as low height flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. For example, the default value applied should be 80%, rather than 90%, and if for example the measured value was 99%, then the value to be used shall correspond to 89%.

This project activity will apply Option A, and thus a default value will be used for the efficiency of the flare.

Option A: Default value

The flare efficiency for the minute *m* ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating: (1) The temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m*; and

(2) The flame is detected in minute *m* ($Flame_m$).

Default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option A of "Project emissions from flaring" version 02.0.0. The flare height installed in the project activity is less than 10 times the diameter. This makes it a low height flare. As per the tool "Project emissions from flaring" version 02.0.0, a low height flare is an enclosed flare for which the flame enclosure has a height between 10 and two times de diameter of the enclosure. Given that the project is using a low height flare, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 80% will be used for the project activity.

In case the monitoring equipment for condition (1) above is unavailable for maintenance, or failure, the following methods will be used for $\eta_{flare,m}$:

- 0% if the temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m, and* the flame is not detected in minute m *(*$Flame_m$*).*
- 50% if the flame is detected in minute m ($Flame_m$), but the temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute *m*. This is applicable for those cases in which the system is unavailable for maintenance or failure.

STEP 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare,m}\right) \times 10^{-3}$$

Tool equation (15)

Variable	*Description*
$PE_{flare,y}$	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	Flare efficiency in minute *m*

(b) Amount of methane in the LFG which is used for electricity generation ($F_{CH4,EL,y}$)

The amount of methane in the LFG which is used for electricity generation in year y ($F_{CH4,EL,y}$) will be determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0, applying the requirements described above where the gaseous stream is the LFG delivered to electricity generation. The Option 2 of the mentioned "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 under the name "Simplified calculation without measurement of the moisture content" will be applied as a simple and conservative approach to determine the absolute humidity of the gaseous stream of $F_{CH4,EL,y}$ by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Since the gaseous stream flow will be measured on volume basis and the volumetric fraction of methane will be measured in dry basis, two options will be used in the project activity:

- Option A will be used in case of dry basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point (way b of Option A), and
- Option B will be used in case of wet basis of the gas, demonstrating that the temperature of the gaseous stream (T_t) is more than 60ºC (333.15 K) at the flow measurement point and by converting the measured volumetric flow from wet basis to dry basis.

The following paragraphs show the formulae which will be used to determine the absolute humidity of the gaseous streams applying the Option 2 "Simplified calculation without measurement of the moisture content" and to determine the flow and volumetric fraction of the gaseous stream applying the Option A and Option B as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0:

- **Option 2: Simplified calculation without measurement of the moisture content**

  This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using equation (4) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 as follows:.

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$

(4) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$m_{H2O,t,db,sat}$	=	Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H20,t,Sat}$	=	Saturation pressure of H_2O at temperature T_t in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}		Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$		Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Parameter $MM_{t,db}$ is estimated using equation (3) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 as follows:

$$MM_{t,db} = \sum_{k} (v_{k,t,db} * MM_{k})$$

(3) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k	=	Molecular mass of gas *k* (kg/kmol)
K	=	All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs). See available simplification below

The determination of the molecular mass of the gaseous stream (MMt,db) requires measuring the volumetric fraction of all gases (k) in the gaseous stream. However as a simplification, the volumetric fraction of only the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

Since methodology ACM0001 version 15.0 states that the simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool), only the volumetric fraction of methane (CH_4) contained in the gaseous stream ($v_{CH4,t,db}$) will be measured because it is the greenhouse gas considered in the emission reduction calculation. Therefore, the difference to 100% will be considered as pure nitrogen.

- **Option A**

Flow measurement on a dry basis is not feasible for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

a) Measure the moisture content of the gaseous stream (CH_2O,t,db,n) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or

b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

For the project activity, the method b) from above will be used so it will be demonstrated that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point. If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the corresponding option from Table 1 should be applied instead. For the project activity Option B will be used.

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

(5) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

With:

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

(6) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

- **Option B**

The mass flow of greenhouse gas i ($F_{i,t}$) is determined using equations (5) and (6) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0. The volumetric flow of the gaseous stream in time interval t on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis using equation (7) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 as follows:

$$V_{t,tb} = V_{t,wb} / (1 + v_{H2O,t,db})$$

(7) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)

The volumetric fraction of H_2O in time interval t on a dry basis ($v_{H2O,t,db}$) is estimated using equation (8) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0 as follows:

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

(8) equation of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0

Where:

Variable		*Definition*
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)
$m_{H2O,t,db}$		Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$MM_{t,db}$		Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
MM_{H2O}		Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of the gaseous stream ($m_{H2O,t,db}$) in the project activity is determined using Option 2 "Simplified calculation without measurement of the moisture content" as specified in the sections above and the molecular mass of the gaseous stream ($MM_{t,db}$) is determined using equation (3) of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 2.0.0.

Step A.1.1: Ex ante estimation of $F_{CH4,PJ,y}$

An *ex ante* estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS (according to equation 2) in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4} \quad \textbf{(5)}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites". The following guidance should be taken into account when applying the tool:

- f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 of this methodology;
- In the tool, *x* begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

The methane generation from the landfill in the absence of the project activity at year *y* ($BE_{CH4,SWDS,y}$), is calculated as per the "Emissions from solid waste disposal sites" V6 as follows:

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

Where:

$BE_{CH4,SWDS,y}$	=	Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e)
Φ	=	Model correction factor to account for model uncertainties
f	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
GWP_{CH4}	=	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	=	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	=	Fraction of degradable organic carbon (DOC) that can decompose
MCF	=	Methane correction factor
$W_{j,x}$	=	Amount of organic type j prevented from disposal in the SWDS in the year x (tonnes)
DOC_i	=	Fraction of degradable organic carbon (by weight) in the waste type j
k_j	=	Decay rate for the waste type j
j	=	Waste type category (index)
x	=	Year since the landfill started receiving wastes [x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)] Note: this definition represents a correction of the Tool as given in ACM0001, Version 15.0:
y		Year for which methane emissions are calculated

Since ACM0001, Version 15.0 further clarifies that "*Sampling to determine the different waste types is not necessary; the waste composition can be obtained from previous studies*", this option has been used for this project activity.

ACM0001 Version 15.0: also states: "*The efficiency of the degassing system which will be installed in the project activity should be taken into account while estimating the ex-ante estimation*." This is taken into consideration through the utilization of capture efficiency value for the total of biogas generated.

At the renewal of the crediting period, the following data should be updated according to default values suggested in the most recently published IPCC Guidelines for National Greenhouse Gas Inventories:

- Oxidation factor (*OX*);
- Fraction of methane in the SWDS gas (*F*);
- Fraction of degradable organic carbon (*DOC*) that can decompose (DOC_f);
- Methane correction factor (*MCF*);
- Fraction of degradable organic carbon (by weight) in each waste type *j* (DOC_j);
- Decay rate for the waste type *j* (k_j).

Respectively, if the most recent IPCC Guidelines suggest different categorization of waste types, solid waste disposal sites or climate conditions, these should be applied respectively.

Determining the amounts of waste types j disposed in the SWDS (Wj,x or Wj,i)

Since only one type of waste is disposed in the landfill site (in this case municipal solid waste) then $W_{j,x} = W_x$ and $W_{j,i} = W_i$ and the waste sampling is not required. For such reason, Application A of the Methodological Tool "Emissions from solid waste disposal sites." (Version 06.0.1) will be used in the project as follows:

Since the administration of the landfill had the specific information on historic information on amounts, composition and origin of the waste in SWDS administration documents, such data is used as a more reliable source.

Step A.2: Determination of $F_{CH4,BL,y}$

This step provides a procedure to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, or to address safety and odour concerns (collectively referred to as *requirement* in this step). The four cases in Table 2 are distinguished. The appropriate case should be identified and the corresponding instructions followed.

Table 2: Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

For the project activity, Case 1 is applicable: "No requirement to destroy methane exists and no existing LFG capture system" is applicable because the legislation applicable at the submission for validation of the project activity did not require landfills to collect nor utilize the gas generated, hence it was not mandated by regulations. As explained on previous sections at the time of the renewal of the crediting period, the new waste management legal regime in South Africa is delimited by the National Environmental Management: Waste Act No. 59 of 2008 (NEM:WA)[12], which was assented on 06/03/2009 as a regulation (NEM: WA Regulations). The NEM:WA does not introduce into South African legislation the requirement for landfill gas to be captured and flared[13]. Therefore, the project participant is not required to capture and flare LFG at the start of the second crediting period by any mandatory law.

Since the landfill gas capture was not mandated by law prior to the implementation of the project activity (and it is not mandated neither at the time of the renewal of the crediting period under the new regulation), the current baseline complies with all relevant mandatory national and/or sectoral policies which have come into effect after the submission of the project activity for validation and are applicable at the time of requesting renewal of the crediting period. Therefore, the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements is 0.

Case 1: *No requirement to destroy methane exists and no existing LFG capture system*

In this situation:

$$F_{CH4,BL,y} = 0 \quad \textbf{(6)}$$

Step B: Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". When applying the tool:

- The electricity sources *k* in the tool correspond to the sources of electricity generated identified in the selection of the most plausible baseline scenario; and

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[12] National Environmental Management: Waste Act No. 59 of 2008. Available at http://www.info.gov.za/view/DownloadFileAction?id=97351

[13] See letter provided to the DOE under the name "SA Landfills Legal Requirements April 2013 "from ENS as a law firm confirming the situation.

- $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year *y* ($EG_{PJ,y}$).
- The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) has been calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" V.1.

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y})$$

- *(2) Equation of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"V.1*

Variable	Definition
$BE_{EC,y}$	Baseline emissions from electricity consumption in year *y* (tCO_2/yr)
$EC_{BL,k,y}$	Quantity of electricity that would be consumed by the baseline electricity consumption source *k* in year *y* (MWh/yr)
$EF_{EL,k,y}$	Emission factor for electricity generation for source *k* in year *y* (tCO_2/MWh)
$TDL_{k,y}$	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*

- *Net quantity of electricity produced using LFG ($EG_{PJ,y}$)*

- Since the project activity has as it purpose to generate electricity using LFG, during the crediting period, it will be measured the electricity produced in power plant station at the site. In the absence of the project activity, this electricity would have been produced by power plants connected to the grid.

- An ex-ante emission factor ($EF_{EL,k,y}$) of 0.9488 tCO_2/MWh has been selected as per the standardized baseline "Grid emission factor for the Southern Africa power pool", version 01.0.

- The average technical transmission and distribution losses in the grid are obtained from Eskom, South African energy utility. The updated TDL values are published annually in Eskom's website. For the purpose of ex-ante calculation of the emission reduction a value of 8.65% has been used, according to the last data available at the time for renewal of the crediting period.

Step C: Baseline emissions associated with heat generation ($BE_{HG,y}$)

Since the project will not generate heat, the baseline emissions associated with heat generation in year y ($BE_{HG,y}$) are 0.

Step D: Baseline emissions associated with natural gas use ($BE_{NG,y}$)

Since the project will not use LFG in natural gas distribution, the baseline emissions associated with natural gas generation in year y ($BE_{NG,y}$) are 0.

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} \qquad \textbf{(7)}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)
$PE_{DT,y}$	=	Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (tCO2/yr)

The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (V.1). When applying the tool:

- $EC_{PJ,k,y}$ in the tool is equivalent to the amount of electricity consumed by the project activity in year *y* ($EC_{PJ,y}$); and
- If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y}$> 0), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the CDM-PDD.

Tool to calculate baseline, project and/or leakage emissions from electricity consumption. V.1

The project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad \textbf{(1)}$$

$\mathbf{PE_{EC,y}}$	Are the project emissions from electricity consumption by the project activity during the year y (tCO_2 / yr)
$\mathbf{EC_{PJ,y}}$	Is the quantity of electricity consumed by the project activity during the year y (MWh),
$\mathbf{EF_{EL}}$	Is the emission factor for the grid in year y (tCO_2/MWh)
$\mathbf{TDL_y}$	Are the average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

When the project does not generate electricity in the first project stage, the assumption made was that the electricity needed for the operation of the project activity will be supplied by the national grid. When the project generates electricity, there is a net export of electricity to the grid (scenario A). For these reasons, the emissions coming from the electricity use are deducted from the overall emissions reductions (this means that only emissions reductions for the net electricity generation are claimed).

For this project activity, Scenario A "Electricity consumption from the grid" is applied.

Parameter $EC_{PJ,y}$ is measured periodically by an electricity meter.

The ex-ante CO_2 emission factor applicable for the project electricity system (project activities other than wind and solar for the second or third crediting period) is 0.9488, as per the standardized baseline "Grid emission factor for the Southern African power pool".

The average technical transmission and distribution losses in the grid are obtained from Eskom, South African energy utility. The updated TDL values are published annually in Eskom's website. For the purpose of ex-ante calculation of the emission reduction a value of 8.65% has been used, according to the last data available.

The project emissions from fossil fuel combustion for purposes other than electricity generation ($PE_{FC,y}$) shall be calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". However, fossil fuel consumption has not been used during the first crediting period, nor is expected to be used during the second crediting period, this is why it has been left out. Thus the "Tool to calculate project or leakage CO_2 emission from fossil fuel combustion" is not applied.

The project will not compress/liquefy the gas nor distribute the LFG using trucks. Therefore the emission reductions from the distribution of compressed/liquefied LFG are zero.

Leakage

No leakage effects are accounted for under this methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(8)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
PE_y	=	Project emissions in year *y* (t CO_2/yr)

Project participants should provide an ex ante estimate of emissions reductions in the CDM-PDD. This requires projecting the future GHG emissions of the SWDS for the calculation of baseline emissions.

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data and parameter.)

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Methodological tool ACM0001 "Flaring or use of landfill gas", version 15.0
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	According to the "Emissions from solid waste disposal sites" – Version 6.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable to Step A (Section 5.4.1 ACM0001, version 15.0)

Data / Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	25
Choice of data or Measurement methods and procedures	Table 2.14 of the Fourth Assessment Report of the IPCCC. Shall be updated for future commitment periods according to any future COP/MOP decisions
Purpose of data	Calculation of baseline emissions
Additional comment	As per Table 2.14 of the Fourth Assessment Report of the IPCCC which can be found at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14

Data / Parameter	**D_{CH4}**
Unit	tCH_4/m^3CH_4
Description	Methane density
Source of data	Tool “Project emissions from flaring”, version 2.0
Value(s) applied	0.000716
Choice of data or Measurement methods and procedures	At standard T and P (0 degrees C and 1,013 bar)
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	φ
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	As per the “Emissions from solid waste disposal sites” –Version 6
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	<table><tr><th></th><th>Humid/wet conditions</th><th>Dry conditions</th></tr><tr><td>Application A</td><td>0.75</td><td>0.75</td></tr><tr><td>Application B</td><td>0.85</td><td>0.80</td></tr></table>
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	F
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	According to the “Emissions from solid waste disposal sites” – Version 6
Purpose of data	Calculation of baseline emissions
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / Parameter	f_y
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
Source of data	According to the “Emissions from solid waste disposal sites” – Version 6
Value(s) applied	0
Choice of data or Measurement methods and procedures	All the methane generated was directly vented to the atmosphere prior to the project activity. Upon the implementation of the project activity, methane captured will only be flared and/or used to generate electricity.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	η_{PJ}
Unit	-
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	As per footnote 4 on page 10/23 of ACM0001 / Version 15.0 "Flaring or use of landfill gas"
Value(s) applied	50%
Choice of data or Measurement methods and procedures	The efficiency of the planned LFG collection, flaring, and utilization system is estimated based on site conditions and the proposed system design by applying the default value proposed as per footnote 4 on page 10/23 of ACM0001 / Version 15.0 "Flaring or use of landfill gas"
Purpose of data	Calculation of baseline emissions
Additional comment	The efficiency of the planned LFG collection, flaring, and utilization system is taken into account for the ex-ante estimation of emission reductions.

Data / Parameter	**MCF**
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1
Choice of data or Measurement methods and procedures	According to the "Emissions from solid waste disposal sites" – Version 6 for managed solid waste disposal sites this value is to be applied to the landfill as it does not have a water table above the bottom of the landfill, there is control placement of waste and includes at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

<table>
<tr><td>Data / Parameter</td><td>DOC_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon (by weight) in the waste type j.</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Waste type j</th><th>DOC_j (%wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>In accordance with "Emissions from solid waste disposal sites" – Version 6</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The values applied are for wet waste.</td></tr>
</table>

Data / Parameter	**DOC_f**
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	According to the “Emissions from solid waste disposal sites” – Version 6
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

<table>
<tr><td>Data / Parameter</td><td>k_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j.</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperate (MAT≤20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th><th>Dry (MAP< 1000mm)</th><th>Wet (MAP> 1000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>The Mariannhill Landfill is located in Durban (South Africa), which has a mean annual temperature (MAT) of 20.8ºC and mean annual precipitation (MAP) of 1009 mm. Data on potential evapotranspiration (PET) is 4. Therefore, the site is based in a Tropical/Temperate climatic conditions (MAT>20C) and wet precipitations (MAP>1000 mm)</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>http://www.worldweather.org/035/c00137.htm</td></tr>
</table>

Data / Parameter	**$EF_{EL,k,y}$** (equivalent to $EF_{grid,CM,y}$ from the Standardized Baseline)
Unit	tCO_2/MWh
Description	CO_2 emissions intensity of the electricity displaced
Source of data	Standardized baseline “Grid emission factor for the Southern African power pool”, version 01.0.
Value(s) applied	0.9488
Choice of data or Measurement methods and procedures	According to the standardized baseline “Grid emission factor for the Southern African power pool”, version 01.0.
Purpose of data	Calculation of baseline emissions and Calculation of project emissions
Additional comment	The value will be kept fixed for the entire crediting period.

Data / Parameter	$\eta_{flare,m}$
Unit	%
Description	Flare Efficiency in the minute *m*
Source of data	As per “Project emissions from flaring” (Version 02.0.0)
Value(s) applied	0, 0.5 or 0.8 (0.8 is used in *ex ante* calculations)
Choice of data or Measurement methods and procedures	The default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option A (1) of “Project emissions from flaring” version 02.0.0. The flare height installed in the project activity is less than 10 times the diameter. This makes it a low height flare. As per the tool “Project emissions from flaring” version 02.0.0, a low height flare is an enclosed flare for which the flame enclosure has a height between 10 and two times de diameter of the enclosure. Given that the project is using a low height flare, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 80% will be used for the project activity. In case the monitoring equipment for the (1) flare temperature or (2) flare manufacturer specifications is unavailable for maintenance, or failure, the following methods will be used for $\eta_{flare,m}$: • 0% if the temperature of the flare (T_{EGm}) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer’s specification for the flare ($SPEC_{flare}$) in minute *m, and* the flame is not detected in minute m *(*$Flame_m$*).* • 50% if the flame is detected in minute *m* ($Flame_m$), but the temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are not within the manufacturer’s specification for the flare ($SPEC_{flare}$) in minute *m*. This is applicable for those cases in which the system is unavailable for maintenance or failure.
Purpose of data	The default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option A (1) of “Project emissions from flaring” version 02.0.0. For ex ante estimation of $F_{CH4,PJ,y}$, the estimate baseline emission of methane from the SWDS (according to equation 2) in order to estimate the emission reductions of the proposed project activity in the CDM-PDD are conducted following the tool "Emissions from solid waste disposal sites" (Version 06.0.1)
Additional comment	According to the tool “Project emissions from flaring” version 02.0.0, for enclosed flares that are defined as low height flares, the flare efficiency in the minute m shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Options A or B. For example, the default value applied should be 80%, rather than 90%.

Data / Parameter	R_u
Unit	Pa.m^3/kmol.k
Description	Universal ideal gases constant
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Value(s) applied	Compound: Methane; Structure: CH_4; Molecular mass (kg/kmol): 16.04
Choice of data or Measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Compound	Structure	Molecular mass (kg/kmol)
Methane	CH_4	16.04

Data / Parameter	P_n
Unit	Pa
Description	Total pressure at normal conditions
Source of data	“Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Value(s) applied	101,325 Pa
Choice of data or Measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, Version 02.0.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	T_n
Unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 02.0.0
Value(s) applied	273.15 K
Choice of data or Measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 02.0.0
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$SPEC_{flare}$
Unit	Temperature: °C Flow rate: Nm^3/h
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule: MinimumTemperature: 500°C Minimum Flow rate: 100 Nm^3/h
Source of data	Flare manufacturer
Value(s) applied	NA
Choice of data or Measurement methods and procedures	(a) Minimum flow rate, converted to flow rate at reference conditions ; (b) Minimum operating temperature
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

Baseline emissions

Step A: Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account. As a result, the following table below contains the $BE_{CH4,y}$ values obtained from the application of equation (2) of ACM0001 Version 15.0:

Table 1. Annual calculation for $BE_{CH4,y}$

Period		$BE_{CH4,y}$ (tonnes of CO2)
Start Date	End Date	
15/12/2013	14/12/2014	53,491
15/12/2014	14/12/2015	55,939
15/12/2015	14/12/2016	57,792
15/12/2016	14/12/2017	58,813
15/12/2017	14/12/2018	59,641
15/12/2018	14/12/2019	60,227
15/12/2019	14/12/2020	43,873
Total		**389,776**
Annual average		**55,682**

The above results have been calculated from the following values:

Step A.1.1: Ex ante estimation of $F_{CH4,PJ,y}$

An *ex ante* estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS (according to equation 2) in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. $BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites".

The methane emissions avoided during the year from preventing waste disposal at the solid waste disposal in the site have been calculated as follows applying the inputs values specified in Appendix 3. The following table summarizes the results:

Table 2. Annual calculation for $BE_{CH4,SWDS,y}$

Period		$BE_{CH4,SWDS,y}$ (tonnes of CO2)
Start Date	End Date	
15/12/2013	14/12/2014	111,761
15/12/2014	14/12/2015	119,537
15/12/2015	14/12/2016	124,886
15/12/2016	14/12/2017	128,588
15/12/2017	14/12/2018	131,167
15/12/2018	14/12/2019	132,978
15/12/2019	14/12/2020	134,262
Total		**883,179**
Annual average		**126,168**

The next table contains the $F_{CH4,PJ,y}$ values obtained from the application of equation (5) of ACM0001 Version 15.0:

Table 3. Annual calculation for $F_{CH4,PJ,y}$

Period		$F_{CH4,PJ,y}$ (tonnes of CH4)
Start Date	**End Date**	
15/12/2013	14/12/2014	2,377
15/12/2014	14/12/2015	2,486
15/12/2015	14/12/2016	2,569
15/12/2016	14/12/2017	2,614
15/12/2017	14/12/2018	2,651
15/12/2018	14/12/2019	2,677
15/12/2019	14/12/2020	1,950
Total		**17,324**
Annual average		**2,475**

Step B: Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The following table summarizes the results:

Table 4 Annual calculation for $BE_{EC,y}$

Period		$BE_{EC,y}$ (tonnes of CO2)
Start Date	**End Date**	
15/12/2013	14/12/2014	8,466
15/12/2014	14/12/2015	8,466
15/12/2015	14/12/2016	8,466
15/12/2016	14/12/2017	8,466
15/12/2017	14/12/2018	8,466
15/12/2018	14/12/2019	8,466
15/12/2019	14/12/2020	8,466
Total		**59,262**
Annual average		**8,466**

Table 5. Annual calculation for $EG_{PJ,y}$

Period		$EG_{PJ,y}$ (MWh)
Start Date	**End Date**	
15/12/2013	14/12/2014	8,213
15/12/2014	14/12/2015	8,213
15/12/2015	14/12/2016	8,213
15/12/2016	14/12/2017	8,213
15/12/2017	14/12/2018	8,213
15/12/2018	14/12/2019	8,213
15/12/2019	14/12/2020	8,213
Total		**57,491**
Annual average		**8,213**

Step C: Baseline emissions associated with heat generation ($BE_{HG,y}$)

Since the project will not generate heat, the baseline emissions associated with heat generation in year y ($BE_{HG,y}$) are 0.

Step D: Baseline emissions associated with natural gas use ($BE_{NG,y}$)

Since the project will not use LFG in natural gas distribution, the baseline emissions associated with natural gas generation in year y ($BE_{NG,y}$) are 0.

Finally, the following table contains the BE_y values obtained from the application of equation (1) of ACM0001 Version 15.0:

Table 6. Annual calculation for BE_y

Period		BE,y (tCO2e)
Start Date	**End Date**	
15/12/2013	14/12/2014	61,956
15/12/2014	14/12/2015	64,405
15/12/2015	14/12/2016	66,257
15/12/2016	14/12/2017	67,278
15/12/2017	14/12/2018	68,106
15/12/2018	14/12/2019	68,693
15/12/2019	14/12/2020	52,338
Total		**449,033**
Annual average		**64,148**

<u>Project emissions</u>

Project emissions are calculated as follows:

The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (V.1). When applying the tool, the following results have been found:

Table 7. Annual calculation for $PE_{EC,y}$

Period		$PE_{EC,y}$ (tCO2)
Start Date	**End Date**	
15/12/2013	14/12/2014	261
15/12/2014	14/12/2015	261
15/12/2015	14/12/2016	261
15/12/2016	14/12/2017	261
15/12/2017	14/12/2018	261
15/12/2018	14/12/2019	261
15/12/2019	14/12/2020	261
Total		**1,827**
Annual average		**261**

The project emissions from fossil fuel combustion for purposes other than electricity generation ($PE_{FC,y}$) shall be calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". No project emissions from fossil fuel have been considered ex-ante so the following results have been found when applying the tool:

Table 8. Annual calculation for $PE_{FC,y}$

Period		$PE_{FC,y}$ (tCO2)
Start Date	**End Date**	
15/12/2013	14/12/2014	0
15/12/2014	14/12/2015	0
15/12/2015	14/12/2016	0
15/12/2016	14/12/2017	0
15/12/2017	14/12/2018	0
15/12/2018	14/12/2019	0
15/12/2019	14/12/2020	0
Total		**0**
Annual average		**0**

The project emissions in the project activity are calculated as per equation (21) of ACM0001 Version 15.0, with the following results:

Table 9. Annual calculation for $PE_{,y}$

Period		$PE_{,y}$ (tCO2)
Start Date	End Date	
15/12/2013	14/12/2014	261
15/12/2014	14/12/2015	261
15/12/2015	14/12/2016	261
15/12/2016	14/12/2017	261
15/12/2017	14/12/2018	261
15/12/2018	14/12/2019	261
15/12/2019	14/12/2020	261
Total		**1,827**
Annual average		**261**

Leakage

No leakage effects are accounted for under this methodology.

Emission reductions

The emissions reductions expected from the project activity are calculated as per equation (22) of ACM0001 Version 15.0, with the results shown in the following point B.6.4.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
15/12/2013-14/12/2014	61,956	261		61,695
15/12/2014-14/12/2015	64,405	261		64,144
15/12/2015-14/12/2016	66,257	261		65,996
15/12/2016-14/12/2017	67,278	261		67,017
15/12/2017-14/12/2018	68,106	261		67,845
15/12/2018-14/12/2019	68,693	261		68,432
15/12/2019-14/12/2020	52,338	261		52,078
Total	449,033	1,827	0	447,207
Total number of crediting years	7			
Annual average over the crediting period	64,148	261	0	63,887

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$V_{LFG,total,y,db}$
Unit	m³ dry gas/h
Description	Volumetric flow of total landfill gas which is sent to flare and used for electricity generation in year y on a dry basis
Source of data	Calculated
Value(s) applied	(see table below)
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency	Continuous Values are recorded every minute
QA/QC procedures	Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter will be monitored as per Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. No separate monitoring of temperature and pressure is necessary. Flow meters that automatically express LFG volumes in standardised cubic meters will be used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets.

Value(s) applied:

Year Period	$V_{LFG,total,y,db} = LFG_{total,y}$
15/12/2013 – 14/12/2014	7,507,096
15/12/2014 – 14/12/2015	7,850,733
15/12/2015 – 14/12/2016	8,110,688
15/12/2016 – 14/12/2017	8,253,985
15/12/2017 – 14/12/2018	8,370,192
15/12/2018 – 14/12/2019	8,452,506
15/12/2019 – 14/12/2020	6,157,288

Data / Parameter	$V_{LFG,sent\_flare,y,db}$
Unit	m³ dry gas/h
Description	Volumetric flow of landfill gas which is sent to flare in year y on a dry basis
Source of data	Measured by a flow meter
Value(s) applied	<table><tr><th>Year Period</th><th>$V_{LFG,sent\_flare,y,db}$ = $LFG_{flare,y}$</th></tr><tr><td>15/12/2013 – 14/12/2014</td><td>3,872,303</td></tr><tr><td>15/12/2014 – 14/12/2015</td><td>4,215,940</td></tr><tr><td>15/12/2015 – 14/12/2016</td><td>4,475,895</td></tr><tr><td>15/12/2016 – 14/12/2017</td><td>4,619,192</td></tr><tr><td>15/12/2017 – 14/12/2018</td><td>4,735,399</td></tr><tr><td>15/12/2018 – 14/12/2019</td><td>4,817,713</td></tr><tr><td>15/12/2019 – 14/12/2020</td><td>2,522,495</td></tr></table>
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency	Continuous. Values are recorded every minute.
QA/QC procedures	Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter will be monitored in Options A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. No separate monitoring of temperature and pressure is necessary. Flow meters that automatically express LFG volumes in standardised cubic meters will be used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets

Data / Parameter	$V_{LFG,EL,y,db}$
Unit	m³ dry gas/h
Description	Volumetric flow of landfill gas which is used for electricity generation in year y on a dry basis
Source of data	Measured by a flow meter
Value(s) applied	(see table below)
Measurement methods and procedures	Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency	Continuous Values are recorded every minute.
QA/QC procedures	Periodic calibration/verification against a primary device provided by an independent accredited entity such as the manufacturer. Calibration and frequency of calibration is according to manufacturer's specifications, but at least every 2 years.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter will be monitored as per Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. No separate monitoring of temperature and pressure is necessary. Flow meters that automatically express LFG volumes in standardised cubic meters will be used. These readings are then adjusted to normalised cubic meters within the SCADA spreadsheets.

Value(s) applied:

Year Period	$V_{LFG,EL,y,db} = LFG_{electricity,y}$
15/12/2013 – 14/12/2014	3,634,793
15/12/2014 – 14/12/2015	3,634,793
15/12/2015 – 14/12/2016	3,634,793
15/12/2016 – 14/12/2017	3,634,793
15/12/2017 – 14/12/2018	3,634,793
15/12/2018 – 14/12/2019	3,634,793
15/12/2019 – 14/12/2020	3,634,793

Data / Parameter	$\mathbf{T_t}$
Unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measured by a temperature transmitter
Value(s) applied	For ex-ante determination, gaseous stream flow temperature being below 60ºC is adopted.
Measurement methods and procedures	Data will be recorded electronically, and will be kept during the crediting period and two years after.
Monitoring frequency	Continuous
QA/QC procedures	Temperature of the gaseous steam is measured by temperature transmitter. Calibration for the temperature transmitter is not required, as per manufacturer' specifications.
Purpose of data	Calculation of baseline emissions
Additional comment	As per the last version of the "Tool to determine the mass flow of a GHG in a gaseous stream" (Version 02.0.0), Option 2 (Simplified calculation without measurement of the moisture content) will be used to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. This parameter must be monitored continuously to assure that monitored gas is on a dry basis, and for those instances when the temperature is above 60^{o}C make sure that the gas is conservatively converted to dry basis. .

Data / Parameter	$\mathbf{P_t}$
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	Measured by a pressure transmitter
Value(s) applied	For ex-ante determination, gaseous stream flow temperature being below 60ºC is adopted and the value of P_t has been considered as the $P_{H2O,Sat}$
Measurement methods and procedures	Data will be recorded electronically, and will be kept during the crediting period and two years after.
Monitoring frequency	Continuous
QA/QC procedures	Calibration for the pressure transmitter is done as per manufacturer' specifications.
Purpose of data	Calculation of baseline emissions
Additional comment	As explained in section B.6.1, and following the last version of the "Tool to determine the mass flow of a GHG in a gaseous stream" (Version 02.0.0), this parameter is only used in the event the temperature of the gaseous stream flow is above 60ºC, when Option 2 of the tool (Simplified calculation without measurement of the moisture content) needs to be applied to convert the measured volumetric flow from wet basis to dry basis. It will therefore only be reported when required.

Data / Parameter	$p_{H20,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Source of data	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4° Edition 1994, John Wiley & Sons, Inc.
Value(s) applied	-
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature T_t and can be found at reference [1] for a total pressure equal to 101,325 Pa
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$\mathbf{v_{CH4,t,db}}$
Unit	m³ CH_4/m³ dry gas
Description	Volumetric fraction of CH_4 in a time interval t on a dry basis
Source of data	Measured continuously by the project participant using certified equipment
Value(s) applied	For the purpose of ex-ante calculations a default value of 50% has been selected, according to the last on-site measurements available. During the implementation of the project activity, the actual monitoring data will be applied.
Measurement methods and procedures	Continuous gas analyser operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature
Monitoring frequency	Continuous
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter will be monitored as per Options A and B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. The analyser has been installed in the main line between the flare and the booster.

Data / Parameter	**$EG_{PJ,y}$**
Unit	MWh
Description	Amount of net electricity generated using LFG
Source of data	Calculated from the potential renewable electricity produced
Value(s) applied	<table><tr><th>Year Period</th><th>$EG_{PJ,y}$</th></tr><tr><td>15/12/2013 – 14/12/2014</td><td>8,231</td></tr><tr><td>15/12/2014 – 14/12/2015</td><td>8,231</td></tr><tr><td>15/12/2015 – 14/12/2016</td><td>8,231</td></tr><tr><td>15/12/2016 – 14/12/2017</td><td>8,231</td></tr><tr><td>15/12/2017 – 14/12/2018</td><td>8,231</td></tr><tr><td>15/12/2018 – 14/12/2019</td><td>8,231</td></tr><tr><td>15/12/2019 – 14/12/2020</td><td>8,231</td></tr></table>
Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG, with the use of a bi-directional meter
Monitoring frequency	It will be measured continuously using electricity meters.
QA/QC procedures	Data will be measured continuously, recorded electronically, and data will be kept during the crediting period and two years after. Electricity meters will be subject to maintenance as per Eskom procedures.
Purpose of data	Calculation of baseline emissions
Additional comment	Required to estimate the emission reductions from electricity generation from LFG.

Data / Parameter	**$EC_{PJ,y}$**
Unit	MWh
Description	Amount of electricity consumed by the project activity during the year y
Source of data	Electricity meter
Value(s) applied	253 MWh/y for ex-ante calculations (calculated based on data available from previous verifications). During the implementation of the project the actual monitored data will be applied.
Measurement methods and procedures	Measured with an electricity meter.
Monitoring frequency	Data will be measured continuously.
QA/QC procedures	Electricity meter will be calibrated as per manufacturer's specifications, but at least once every 10 years. Electricity meters will be subject to maintenance as per Eskom procedures Data will be recorded electronically, and kept during the crediting period and two years after.
Purpose of data	Calculations of baseline emissions
Additional comment	All the electricity consumed by the project activity is taken from the grid

Data / Parameter	**$Op_{engine,h}$**
Unit	-
Description	Operation of the engine that consumes the LFG
Source of data	GE Energy's recommended maintenance schedule for the engine
Value(s) applied	For ex-ante determination, $Op_{engine,h}$ has been considered to be 1 for 7,500 h/year.
Measurement methods and procedures	For the engine using the LFG monitor that the plant is operating in hour h by monitoring the following: • Products generated: Monitor the generation of electricity generated. $Op_{engine,h}$=0 when: • No products are generated in the hour h Otherwise, $Op_{engine,h}$=1
Monitoring frequency	Hourly
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter	**$Op_{flare,h}$**
Unit	-
Description	Operation of the flare that consumes the LFG
Source of data	Letter from Envitech Projects, entity in charge of the operation of the projects flaring system
Value(s) applied	For ex-ante determination, $Op_{flare,h}$ has been considered to be 1 for 8,488 h/year.
Measurement methods and procedures	For the enclosed flare using the LFG monitor that it is operating in hour h by monitoring the following: • Flame. Flame detection system is used to ensure that the equipment is in operation; $Op_{flare,h}$=0 when: • Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); Otherwise, $Op_{flare,h}$=1
Monitoring frequency	Hourly
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter	**$Flame_m$**
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Source of data	Project participants
Value(s) applied	For ex-ante determination, $Flame_m$ has been considered to be on for 8,488 h/year.
Measurement methods and procedures	Measured using a Ultra Violet detector or Infra-Red or both
Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off.
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of data	Calculation of baseline emissions
Additional comment	Data will be kept for at least two years after the end of the crediting period.

Data / Parameter	$T_{EG,m}$
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Source of data	On-site measurements
Value(s) applied	No value was estimated.
Measurement methods and procedures	Measure the temperature of the exhaust gas in the flare by appropriate temperature measurement equipment (i.e. thermocouple). Measurements outside the operational temperature specified by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the flare. These would normally be expected to be in the middle third of the flare.
Monitoring frequency	Once per minute
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule
Purpose of data	Calculation of baseline emissions
Additional comment	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. These events should be noted in the site records along with any corrective action that was implemented to correct the issue. Monitoring of this parameter is applicable in case of enclosed flares. Measurements are required to determine if manufacturer’s flare specifications for operating temperature are met.

Data / Parameter	$BE_{CH4, SWDS,y}$
Unit	tCO_2e
Description	Methane generation from the landfill in the absence of the project activity at year y
Source of data	Calculated as per the "*Emissions from solid waste disposal sites" – Version 6*
Value(s) applied	(see table below)
Choice of data or Measurement methods and procedures	As per the *"Emissions from solid waste disposal sites" –Version 6*
Purpose of data	Calculation of baseline emissions
Additional comment	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year

Period		**$BE_{CH4,SWDS,y}$ (tonnes of CO2)**
Start Date	**End Date**	
15/12/2013	14/12/2014	111,761
15/12/2014	14/12/2015	119,537
15/12/2015	14/12/2016	124,886
15/12/2016	14/12/2017	128,588
15/12/2017	14/12/2018	131,167
15/12/2018	14/12/2019	132,978
15/12/2019	14/12/2020	134,262
Total		**883,179**
Annual average		**126,168**

Data / Parameter	**TDL_y**
Unit	%
Description	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Source of data	Default value of average technical transmission and distribution losses will be used from the South African national electricity utility, Eskom, at 8.65%. Eskom 2012 Annual Report, available at: http://www.pads.eezeepage.co.za/i/69721, page 10
Value(s) applied	8.65
Measurement methods and procedures	South African national electricity utility, Eskom, at 8.65%. Eskom 2012 Annual Report, available at: http://www.pads.eezeepage.co.za/i/69721
Monitoring frequency	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
QA/QC procedures	Eskom website will be checked annually.
Purpose of data	Calculation of baseline emissions and Calculation of project emissions
Additional comment	

Data / Parameter	**Management of SWDS**
Unit	-
Description	**Management of SWDS**
Source of data	- Original design of the landfill; - Technical specifications for the management of the SWDS; - Local or national regulations.
Value(s) applied	-
Measurement methods and procedures	The Project Entity will be in compliance with their operational manual and procedures.
Monitoring frequency	Annually
QA/QC procedures	Any change in the management of the landfill will be justified by referring to technical or regulatory specifications. Also, it will be documented and filed by the landfill operator.
Purpose of data	-
Additional comment	-

B.7.2. Sampling plan

>>
Since data and parameters monitored in section B.7.1 above are not to be determined by a sampling approach, no description of the sampling plan in accordance with the “Standard for sampling and surveys for CDM project activities and programme of activities” is required.

B.7.3. Other elements of monitoring plan

>>
The following point describes the operational and management structure that the project operator will implement in order to monitor emission reductions achieved by the project activity.

Data collection:

The data is mainly collected automatically through a data logger. The data gathered automatically is gas flow ($V_{LFG,total,y}$, $V_{LFG,sent\_flare,y}$ and $V_{LFG,EL,y}$)), volumetric fraction of methane ($V_{CH4,t}$), temperature in the exhaust gas of the flare ($T_{EG,m}$), operation of the flare station ($Op_{flare,h}$), operation of the electrical plant ($Op_{engine,h}$), net electricity generated ($EG_{PJ,y}$).
A regular visual inspection is carried out by a designated / trained landfill employee. During this inspection, the employee will check the instrumentation and monitoring data such as gas quality, gas flow, vacuum, and flare temperature. Also the employee will analyze the data and adjust the applied vacuum within the landfill to maintain a steady gas quality and flow. Gas quality and vacuum levels also will be periodically checked directly at each gas well, using a portable meter. This routine monitoring allows to identify underperforming gas wells and to take necessary corrective actions. The combination of these two inspections optimises the landfill gas collection efficiency.

Data Storage:

Data will be monitored and archived, being kept for at least two years after the end of the crediting period.

Project Management Responsibility:

The project implementation and operation will be under the direct supervision of the Landfill Manager. The following table summarizes the roles and responsibilities of project sponsor with regard to the monitoring system for the project:

Task	
Monitoring system	• Develop and establish management and operations system • Establish and maintain monitoring and reporting system and implement MP • Prepare for initial verification and start of project operation
Data Collection	• Establish and maintain data measurement, collection and record keeping systems for landfill gas collection and power supply • Check data quality, collection and record keeping procedures regularly
Data computation	• Complete MP workbook • Or develop and use equivalent recording, calculation and reporting tool for ERs
Data storage systems	• Implement record maintenance system • Store and maintain records (paper trail) • Implement sign-off system for records and completed worksheets

Task	
Performance monitoring and reporting	• Analyze data and compare project performance with project targets • Analyze system problems and implement improvements (performance management) • Prepare and forward annual report and worksheets to WB CFU
Quality assurance and verification	• Establish and maintain quality assurance system with a view to ensuring transparency and allowing for audits and verification • Prepare for, facilitate and co-ordinate audits and verification process

Training of monitoring personnel:

The monitoring personnel will be trained internally or externally as per requirements identified. Training will include:

- Landfill gas collection system balancing;
- Calibration of monitoring equipment; and
- Impact of the monitoring on the CDM activity

Procedure in case of Failure:

If there is an equipment (flow meter, gas analyser, gauge, etc.) failure, the corresponding entity/person (i.e., Landfill Manager, equipment supplier) will be immediately notified. If possible, repairs will be carried out onsite. If the damaged equipment cannot be repaired, it will be replaced by the same or an equivalent unit as soon as possible. In some cases, portable tools will be used in order to carry out daily monitoring of the missing parameter(s). These data will be recorded on paper.

If the flare is not operational, landfill gas will not be combusted and therefore no credits will be claimed during this period.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
The CDM-PDD for the second crediting period, with the application of methodology ACM0001 version 15.0, and Standardized Baseline “Grid emission factor for the Southern African power pool”, (version 01.0) and their tools as mentioned in section B.1, was completed on 28/01/2014 and was prepared by

Sergi Cuadrat
ClimaLoop
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in collaboration with
Patricia Marcos Huidobro and
Claudia Barrera,
pmarcoshuidobro@worldbank.org
cbarrera@worldbank.org
Carbon Finance Unit
World Bank

None of the above is project participants

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>
15/12/2006

C.1.2. Expected operational lifetime of project activity

>>
21 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>>
Renewable

C.2.2. Start date of crediting period

>>
The second crediting period comprises the period from 15/12/2013 to 14/12/2020 (both days included).

C.2.3. Length of crediting period

>>
Seven years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
eThekwini Municipality sought legal advice and held a subsequent meeting with the competent authorities overseeing the application of ESIA legislation in KwaZulu Natal province, the conclusion of which was to confirm that a full ESIA process is required. The Bank team wished to ensure that the current ESIA team (Felehetsa Consultants) include expert and seasoned personnel regarding public consultation and conflict case mediation. The Manager of Environment for eThekwini Municipality responded that she herself, and the Municipality more generally, would play a strong role in the preparation of the ESIA, and that other steps had been taken to ensure that such expertise was included in the ESIA team.

In order to assess the air quality impacts of the proposed landfill gas utilization project at the Mariannhill and La Mercy Landfill sites in Durban, South Africa, Felehetsa Environmental (Pty) Ltd appointed Enviros Consulting (of the UK) on behalf of Durban Solid Waste to carry out an atmospheric dispersion modeling study of emissions from the landfill sites.

The atmospheric dispersion modeling results indicated that the predicted concentrations of the modeled substances for combustion and fugitive releases (landfill gas engines and flares), were within the relevant air quality standards.

On this basis, and despite adoption of some worst case assumptions in the modeling approach, emissions of these substances are predicted to have no significant effects on human health. Monitoring to verify the results of the modeling study is proposed.

Furthermore, utilization of landfill gas to generate electricity, thereby displacing the use of other fuel will mean that a wider scale reduction in air pollution emissions will be achieved. This will offset the increase in combustion-related emissions associated with electricity generation. It is therefore considered that, as no air quality benchmarks are forecast to be exceeded, the use of landfill gas engines as planned comprises best practice for management of landfill gas.

D.2. Environmental impact assessment

>>

The Mariannhill Landfill Gas to Energy project has positive effects on local air and groundwater quality and safety. By displacing electricity from the grid the project reduces emissions related to coal-fired power production which include sulfur oxides, nitrogen oxides and particulates. It also reduces the adverse impacts related to transportation of coal and coal-mining (dust and acid mine drainage). Near the landfill site the project improves local air quality by further reducing the amount of landfill gas released into the atmosphere and thus reducing the risk of dangerous methane gas concentrations and of exposure of neighboring residents to odor. This is particularly relevant for the Mariannhill landfill site which is located close to residential areas. All gas capturing wells to be installed will be equipped for leachate removal which contributes to the protection of groundwater. The provision of up to 2MW in electricity will reduce local pollution from fossil-fuel plants, the generation source for most electricity at present.

With regard to local employment the project will result in a small increase in the area of skilled jobs for operation and maintenance of the equipment at the landfill and the power generation units.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>

eThekwini Municipality and national legislation calls for the establishment and regular meeting of a Monitoring Committee, comprising interested and affected parties. This committee meets on a quarterly basis. The proposed project was discussed in the Committee Meeting held in November 2002. Documentation to support this is available in the form of minutes. The environmental and social impacts of the construction and operation of the project were described.

In July 1997 the Mariannhill Landfill Site was commissioned to receive “General” (G) waste in accordance with a permit issued by the Department of Water Affairs and Forestry (DWAF, 1994 and updated 1998). The Mariannhill Landfill Monitoring Committee was formulated in 1996 and commenced meetings prior to the site opening, to ensure upon public ‘buy-in’ from the onset of disposal operations. 6 monthly audits became a legislation requirement as did regular 3-monthly meetings with the community, termed “the Monitoring Committee”.

The Monitoring Committee is a body established by all parties interested and/or affected by the landfill site which includes stakeholders, and meets on a regular basis to discuss issues related to the landfill at Mariannhill Landfill. Due to La Mercy’s isolated location in an uninhabited area no Monitoring Committee was established for this site, nor has it been called for by DWAF.

The Mariannhill Landfill Conservancy was established in 1998, and received National Conservancy Certification status in 2003.

The Mariannhill and La Mercy sites received positive Records of Decision (RODs) from the Provincial Department of Agriculture and Environmental Affairs (DAEA) on 9 July 2004, but an appeal was issued by a member of the public, Mr Allan Childs, on 2 August, 2004 (the details of which are summarised in G2). This appeal was rejected by the DAEA in early 2005, following a

review period of some 5 months. However, the DAEA initially imposed conditions on this decision to reject the appeal that are detailed in G.3.

In order to assess the air quality impacts of the proposed landfill gas utilisation project at the Mariannhill and La Mercy Landfill sites in Durban, South Africa, Felehetsa Environmental (Pty) Ltd appointed Enviros Consulting (of the UK) on behalf of Durban Solid Waste to carry out an atmospheric dispersion modelling study of emissions from the landfill sites.

E.2. Summary of comments received

>>

Mr Allan Childs, a member of the public, submitted the following grounds for appeal against the RODs for the sites at Mariannhill and La Mercy:

a. Clauses in the Key Decision Factors of the RODs and the benefits of the projects to city residents

i. Mr Childs had no objection to the proposals overall but felt that they were aimed at increasing the prestige of the eThekwini Municipality rather than combating global warming. The benefits to residents of the city if any would be miniscule in his view. The appreciation of the Rand has already reduced the benefits by 20%.

b. Clauses related to design criteria and atmospheric impacts in the Key Decision Factors of the RODs

11. Clauses 8.6.2 and 8.6.3 of the ROD state that the spark ignition engines will be specified to the latest European design notably for exhaust emission but these actual specifications will not be finalized until the contracts are awarded. Clauses 8.8.1.2 requires an independent air monitoring exercise to be undertaken to assess the actual impact of any emissions and clause 8.8.1.3 says that the emission limits will be set and the engines managed and monitored to ensure emission levels set (presumably as a result of the monitoring exercise) are not exceeded. Mr Childs found this to be unacceptable.

Setting the specification for exhaust based on the results of tests carried out after commissioning was equally unacceptable to Mr Childs.

Finally, he noted that there are no test facilities in South Africa for dioxin and furans. Consequently unless it is recognized that these materials could be present in the exhaust no effort will be made to test for them. He requested, therefore, that these requirements be specified in the ROD.

E.3. Report on consideration of comments received

>>

Based on the comments received above, and an expert analysis of the merit of those comments, the appeal submitted by Mr Childs was rejected, with the imposition of certain conditions. The projects on the Mariannhill and La Mercy landfill sites were initially granted authorization to proceed as pilot plants for a period of 2 years only.

Existing conditions of approval were amended and amplified as follows:

- The applicant (project sponsor) must undertake the air quality monitoring exercise stipulated in condition 9.2.2 of the ROD in consultation with the DAEA. The DAEA must be consulted with respect to the establishment, operation, assessment and analysis of the air quality monitoring systems.

- The air monitoring exercise prescribed in condition 9.2.2 of the ROD will constitute an initial assessment. The applicant must develop an ongoing air quality impact assessment program to

monitor emissions over the 2 year period, as envisaged in conditions 9.2.8 and 9.2.9 of the ROD.

- The results of all air quality monitoring must be incorporated into the prescribed landfill site audits for the Mariannhill and La Mercy landfill sites, and these results must be presented to the monitoring committee forums for each site.

- The air quality impact assessments undertaken for each site must upon completion, be submitted to the DAEA's sub-directorate on air quality, and also to the applicant's own environmental health unit (air quality management section) for comments.

- The results of the ongoing air quality impact assessment process conducted over the 2 year period must be measured against the baseline condition 9.2.2 of the ROD, and results reported to the DAEA.

- Pending the establishment of South African air quality standards, the applicant will be obliged to ensure that their emission limits do not exceed those established in the "Guidance of Monitoring Landfill Gas Engines, United Kingdom Environment Agency, Draft for Consultation, 2002"

- At the end of the 2 year pilot period of the project the DAEA will consider the results of the air quality monitoring and assessment programmes to inform future decisions regarding the continued operation of the projects.

- EIA applications for the permanent operation of the LFG capture and electricity generation and distribution facilities on both the Mariannhill and La Mercy landfill sites were to be considered by the DAEA at the end of the 2 year pilot project period.

Following the study performed by Enviros Consulting, commissioned by Felehetsa Consultants on behalf of DSW, it was concluded that the atmospheric dispersion modelling results indicate that the predicted concentrations of the modelled substances for combustion and fugitive releases (landfill gas engines and flares), are within the relevant air quality standards.

On this basis, and despite adoption of some worst case assumptions in the modelling approach, emissions of these substances are predicted to have no significant effects on human health. Monitoring to verify the results of the modelling study is proposed.

Furthermore, utilisation of landfill gas to generate electricity, thereby displacing the use of other fuel will mean that a wider scale reduction in air pollution emissions will be achieved. This will offset the increase in combustion-related emissions associated with electricity generation. It is therefore considered that, as no air quality benchmarks are forecast to be exceeded, the use of landfill gas engines as planned comprises best practice for management of landfill gas.

DSW then submitted a request to the KwaZulu Natal Department of Agriculture and Environmental Affairs, requesting a review of the 'pilot project'conditions imposed up on the project's implementation. In an amended ROD, dated 16/11/2005, para 3.3.2 notes that" the content of the new information indicates that the air quality impacts associated with the landfill gas projects will not only be acceptable, but will apparently improve the ambient quality of the air." Para 3.4.3 notes that: "The department [Department of Agriculture and Environmental Affairs, KwaZulu-Natal] has notified the only appellant to the original RODs of your request, and submitted the new information to him for comment. The appellant was the only party concerned with the air quality impacts and

the assessment thereof in the original EIA process. There are consequently no other parties who have an interest in the new information, nor will the silent majority's interests, health or well-being be adversely affected in any respects by the decision to amend the conditions, given that the air quality impacts that would have arisen should the projects have been commissioned after the original RODs were issued will in no respects change as a result of the new information or of this department's decision to amend the conditions."

Detailed background

Durban Solid Waste provided Enviros with some information on the site-specific parameters, and other input data for the modelling assessment was obtained from UK guidance. A number of key assumptions, taken from UK guidance, were made for the modelling assessment and a conservative approach was taken. The forecast levels of pollutants are based on UK data. Baseline air quality was taken from actual monitoring data where available and a number of sensitive receptors were identified. The atmospheric dispersion modelling results for the both scenarios indicate that the predicted concentrations of the modelled substances for combustion releases (landfill gas engines and flares), are within the relevant air quality standards.

The Emission Concentration Standard used for dioxins and furans from enclosed LFG flares is 0.18 ng/Nm^3. This is a proposed German standard quoted in draft UK Environment Agency guidance (Ref 10), but not adopted as UK standard. (p18 of AQ study).

The Emission Concentration Standard used for dioxins and furans from landfill gas engines is 0.1 ng/Nm3. This is a German HmfUR standard quoted in draft UK Environment Agency guidance (Ref 14), but not adopted as UK standard. (p 20 of AQ study).

Dispersion modelling was undertaken at the receptor location where the highest pollutant concentrations are forecast. Lower concentrations were forecast at all other receptors. The maximum modelled concentration of dioxins and furans in the absence of the project is 4.5 x 10(-10)µg/m3. With the project the maximum modelled concentration is 1.1 x 10 (-9)µg/m^3. (pp 28 and 29 of AQ study). This is still well below the allowed standard of 0.18 ng/Nm^3.

The actual dioxin and furan emissions from flare and engine exhaust emissions will be monitored using extractive sampling to sorbent tube separated by high resolution gas chromatography (HRGC), and measured by high resolution mass spectrometry (HRMS).

SECTION F. Approval and authorization

>>

The letters of approval from Parties for the project activity are available at the time of submitting the PDD to the validating DOE for the renewal of the crediting period.

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Durban Solid Waste (DSW)
Street/P.O. Box	17 Electron Road, Springfield, PO Box 1038
Building	
City	Durban
State/Region	Kwazulu-Natal
Postcode	4000
Country	South Africa
Telephone	27 (0)31 302 4821
Fax	27 (0)31 263 1119
E-mail	
Website	
Contact person	
Title	Project Manager
Salutation	Mr.
Last name	Wright
Middle name	
First name	Marc
Department	Unicity Landfills
Mobile	27 (0)83 631 2682
Direct fax	27 (0)31 263 13107
Direct tel.	27 (0)31 263 1371/2
Personal e-mail	Marc.Wright@dmws.durban.gov.za

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	eThekwini Municipality
Street/P.O. Box	No address
Building	
City	
State/Region	
Postcode	
Country	South Africa
Telephone	
Fax	
E-mail	
Website	
Contact person	
Title	Municipal Manager (this position changes every 5 years)
Salutation	

Last name	
Middle name	
First name	
Department	
Mobile	
Direct fax	27(031) 311 2170
Direct tel.	27 (031) 311 2100
Personal e-mail	msmdb@mweb.co.za

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	International Bank for Reconstruction and Development (IBRD) as Trustee of the Prototype Carbon Fund (PCF)
Street/P.O. Box	1818 H Street, NW
Building	MC Building
City	Washington
State/Region	DC
Postcode	20043
Country	United States of America
Telephone	
Fax	
E-mail	Ibrd-carbonfinance@worldbank.org
Website	www.carbonfinance.org
Contact person	
Title	Manager
Salutation	Mr.
Last name	Widge
Middle name	-
First name	Vikram
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Direct tel.	+1-202-458-5051
Personal e-mail	ibrd-carbonfinance@worldbank.org

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Government of Finland- Ministry of Foreign Affairs
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Website	
Contact person	Mr Marko Berglund
Title	Chief Administrator
Salutation	
Last name	Berglund
Middle name	
First name	Marco
Department	Unit for International Environment Policy
Mobile	
Direct fax	
Direct tel.	358 295 899
Personal e-mail	Marko.Berglund@formin.fi

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Fortum Corporation
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State/Region	
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Country	Finland
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Website	
Contact person	Holmberg Mans
Title	Head of Environmental Value Trading & Head of Sales Asset Backed Trading
Salutation	Mr.
Last name	Mans
Middle name	
First name	Holmberg
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	Mans.Holmberg@fortum.com

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	GDF SUEZ
Street/P.O. Box	Simon Bolivariaan 34,
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City	1000 Brussels
State/Region	
Postcode	
Country	Belgium
Telephone	+32 (2) 5195127
Fax	+32 (0) 2 501 59 16
E-mail	Oleksandr.Mykhaylovin @gdfsuez.com
Website	
Contact person	Oleksandr Mykhaylovin
Title	CDM Originator
Salutation	Mr.
Last name	Mykhaylovin
Middle name	
First name	Oleksandr
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	Oleksandr.Mykhaylovin@gdfsuez.com
Represented by (alternate)	Christine Faure-Fedigan
Title	DSDD – Strategy and Sustainable Development
Salutation	Ms.
Last name	Faure-Fedigan
Middle name	
First name	Christine
Department	CO2 Strategy. Sustainable Development Division
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Appendix 2. Affirmation regarding public funding

There is no public funding from Parties included in Annex 1 for the proposed project activity.

Appendix 3. Applicability of methodology and standardized baseline

Please refer to section B.2.

Appendix 4. Further background information on ex ante calculation of emission reductions

Further background information on methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site

The following inputs have been used to calculate the $BE_{CH4,SWDS,y}$.

Table 10 Baseline determination information

Data	Value	Unit	Source
Year of opening	2002	Year	Landfill information
Year of closure	2020	Year	Landfill information
Waste composition Wood and wood products Pulp, paper and cardboard Food waste Textiles Garden waste Inert waste	 0% 0% 56% 0% 6% 0%	Percentage of total waste	Landfill information
MCF	1		IPCC 2006
K (decay rate) Wood and wood products Pulp, paper and cardboard Food waste Textiles Garden waste Inert waste	 0.035 0.07 0.4 0.07 0.17 0	-	IPCC 2006 For tropical wet climate
DOCf	0.5		IPCC 2006
DOCj Wood and wood products Pulp, paper and cardboard Food waste	 43 40 15	%	IPCC 2006 Wet Waste

Textiles Garden, Yard and Park Waste Inert waste	24 20 0		

Table 11. Domestic waste to be deposited annually.

Waste deposition data	
Year	**Domestic waste load (tons)**
2002	16,439
PEN2003	140,020
2004	162,118
2005	195,059
2006	223,715
2007	224,020
2008	219,600
2009	175,608
2010	192,545
2011	210,110
2012	250,215
2013	210,600
2014	257,400
2015	257,400
2016	257,400
2017	257,400
2018	257,400
2019	257,400
2020	20,000

Table 12 Mean annual meteorological values for the site temperature and rainfall.

Month	Mean temperature (Celsius)	Mean precipitation (mm)
Jan	24.5	134.0
Feb	24.6	113.0
Mar	24.0	120.0
Apr	21.8	73.0
May	19.2	59.0
Jun	16.8	28.0
Jul	16.6	39.0
Aug	17.7	62.0
Sep	19.3	73.0
Oct	20.4	98.0
Nov	21.8	108.0
Dec	23.5	102.0
Mean annual	**20.81**	**1009**

Table 13. Ex-ante estimation of the methane generation from the landfill in the absence of the project activity (Emissions from solid waste disposal sites" –Version 6):

Period		$BE_{CH4,SWDS,y}$ (tonnes of CO2)
Start Date	**End Date**	
15/12/2013	14/12/2014	111,761

15/12/2014	14/12/2015	119,537
15/12/2015	14/12/2016	124,886
15/12/2016	14/12/2017	128,588
15/12/2017	14/12/2018	131,167
15/12/2018	14/12/2019	132,978
15/12/2019	14/12/2020	134,262
Total		**883,179**
Annual average		**126,168**

Further background information on project emissions due to electricity consumed on site

The GHG emission calculation of the proposed project was based on the standardized baseline "Grid emission factor for the Southern African power pool", version 01.0 (CDM-EB73-A03) According to this standardized baseline, a combined margin CO_2 emission factor ($EF_{grid,CM,y}$) of 0.9488, which is applicable to all project activities other than wind and solar for the second or third crediting period, has been selected.

Appendix 5. Further background information on monitoring plan

Please refer to section B.7.

Appendix 6. Summary of post registration changes

A first Request for Deviation from the registered PDD was made in March 2007[14], which got the approval on July 2007 from the CDM EB on two observed deviations from the registered document, namely:

- Use of an alternative method to calculate of the amount of landfill gas collected from project wells at the Mariannhill site due to the absence of a flow meter specifically recording flow from such wells; and
- Consideration of the electricity used by the project equipment at both sites, which is supplied by the grid, in evaluating net electricity exports.

Another Request for Deviation I-DEV0429[15] was submitted on 17/11/2011 for the 2nd monitored period and approved by the UNFCCC on 28/12/2011. The request addressed:

- Failure to monitor combustion efficiency. As no heat rate values have been measured during the monitoring period from 02/11/2007 to 28/02/2010, the use of heat rate values provided by the technology provider upon commissioning of the equipment has been approved as the basis for the calculations for the primary method; and
- Failure to monitor engine heat rate during the Monitoring Period. The deviation from monitoring this parameter was accepted because failure to monitor it has no impact on the

[14] This request was submitted by the first verifying DOE: JCI. For complete details please refer to the website at http://cdm.unfccc.int/Projects/deviations/96737

[15] Request I-DEV0429, can be found online at http://cdm.unfccc.int/Projects/deviations/76947

calculation of emission reductions, and during this period the combustion engines were still new and underwent proper maintenance.

A Notification of Changes to the PDD was submitted to the UNFCCC on 01/07/2011 to address the decommissioning of the La Mercy site which took place in June 2009. The NoC to the PDD was approved with corrections by the CDM EB on its 65th meeting on 25/11/2011. Corrections consist ofthe calculation of theoretical methane emissions using the first order decay (FOD) model for each monitoring period as a quality assurance method, to confirm the methane calculated by using the proposed approach for the monitoring and determination of the parameter "amount of landfill gas collected from the project wells".

A Request for Revision of the Monitoring Plan was submitted to the UNFCCC on 01/07/2011. The request included changes to the monitoring of the following parameters: $MV_{project,y}$, Methane content of the landfill gas, Amount of net electricity sold to the grid, Combustion Efficiency, LFG Temperature and Pressure, Flare working hours, Flare Temperature and Heat rate of the generator. The request was approved with corrections by the Meth Panel on its 53rd meeting, and also with corrections by the CDM EB on its 65th meeting on 25/11/2011.

A Request for Revision of the Monitoring Plan in this PDD (completion date 30/06/2015) includes corrections to the registered PDD that do not affect the project, and the following permanent changes to the registered monitoring plan:

1. Removal of the following parameters for LFG volume on wet basis: $V_{LFG,total,y,wb}$, $V_{LFG,sent\_flare,y,wb}$ and $V_{LFG,EL,y,wb}$;
2. Revision of QA/QC procedure for parameters $V_{LFG,total,y,db}$, $V_{LFG,sent\_flare,y,db}$ and $V_{LFG,EL,y,db}$;
3. Update the flow diagram;
4. Incorporate parameter $SPEC_{flare}$ in section B.6.2 as per the tool “Project emissions from flaring” version 2;
5. Incorporate parameter $p_{H2O,t,Sat}$ as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0);
6. Update QA/QC and monitoring frequency for parameters T_t and P_t;
7. Update parameter $EG_{PJ,y}$.
8. Parameter $Op_{flare,h}$: As per onsite only a flame detection is used for determination of the flare operation however two criteria are mentioned in PDD.
9. Ex-ante fixed parameter OX has been deleted as already parameter OX_{top_layer} in line with methodology ACM0001 is given.

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Document information

Version	*Date*	*Description*
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Editorial improvement.

Version	*Date*	*Description*
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;* • Editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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