PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Huaycoloro landfill gas capture and combustion
Version number of the PDD	4.4
Completion date of the PDD	13/05/2014
Project participant(s)	• Peru: Petramas S.A • Netherlands: International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF). • United Kingdom of Great Britain and Northern Ireland: ICECAP Carbon Portfolio Ltd. • Germany: Statkraft Markets GmbH
Host Party(ies)	Peru
Sectoral scope and selected methodology(ies)	Sectoral Scopes: 01 (Energy Industries –renewable/non-renewable sources) and 13 (Waste Handling and Disposal) Methodology: ACM0001: Flaring or use of landfill gas, Version 15.0.0
Estimated amount of annual average GHG emission reductions	294,903 tCO_2e

SECTION A. Description of project activity
A.1. Purpose and general description of project activity
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The project's purpose is to reduce greenhouse gases ("GHG") emissions, in particular reduce methane ("CH4") emissions through combusting Huaycoloro's landfill gas ("LFG") to generate electricity up to a generation capacity of 5.74 MW[1] and flaring the remaining LFG that is not fed into the electricity generation system; and reduce carbon dioxide ("CO2") emissions through supplying renewable electricity to the SEIN-National Interconnected Electricity System (thus displacing fossil fuel-based electricity generation that would have emitted CO2). The capture and combustion of CH_4, which is typically a 40%-to-60% component of LFG, in engine generators and LFG flare, transforms CH_4 into CO_2[2] and water. This process results into a substantial net reduction of GHG emissions, because of the avoidance of CH_4 release into the atmosphere, which would occur under Huaycoloro landfill's normal operating circumstances ("the business as usual").

Prior to the start of the implementation of the project activity, there was no destruction of CH_4 neither through LFG combustion nor energy generation. Therefore, the scenario existing prior to the implementation of the project activity was no methane collection or destruction leading to CH_4 release into the atmosphere. The situation before the project implementation coincides with the baseline scenario.

Huaycoloro landfill is in compliance with all Peruvian regulations for Solid Waste Management (SWM) activities[3]. Huaycoloro landfill opened in 1994 and is anticipated to remain open until about 2040, with a total capacity of approximately 40 million tons of solid waste. Huaycoloro landfill is currently filling at a rate of approximately 2,200 tons per day, and presently has about 12.6 million tons of waste in place.

Figure 1. Overview of the Huaycoloro Landfill Site

The project is entering in its second crediting period and during the first crediting period, the project implemented the following list of the facilities:

[1] The generation capacity of 5.74 MW was considered as the maximum capacity of the project. However, from 12/11/2011, the project has installed 4.8 MW of generation capacity.
[2] CO2 emissions from Solid Waste ("SW") are not considered to contribute to global climate change because the carbon was contained in recently living biomass. The same CO2 would be emitted as a result of the natural decomposition process.
[3] Huaycoloro's landfill activity would be particularly regulated by the General Law of Solid Residues of 2002 (Law 27314).

Equipment	Description and Capacity	Operational date (Age)	Operational Lifetime[4]
LFG Collection System	Vertical extraction wells drilled in the surface of the landfill and connected by pipe made of high density polyethylene (HDPE) to transport the LFG through the system[5].	05/03/2007 (6 years 7 months)	15 years
LFG Combustion System	An automated station for the capture and combustion of LFG provided by John Zink Company. The combustion of LFG is in an enclosed flare (ZTOF Type). The maximum flow of LFG of the flare is 4000 SCFM (equivalent to 6430 Nm3/h)	05/03/2007 (6 years 7 months)	15 years
LFG Pre-treatment System	The pre-treatment is composed by a chiller (to reduce humidity of LFG) and a cleaning system (to reduce particulates and compounds which can damage the engines).	12/11/2011 (2 years)	15 years
Electricity generation System	Three LFG Engines provided by Caterpillar (model G3520C) with capacity of 1,6 MW each, providing a total capacity of 4,8 MW.	12/11/2011 (2 years)	15 years
Diesel Backup Generator	The diesel backup generator is used in case there is a downtime period of the electricity grid.	05/03/2007 (6 years 7 months)	15 years

During the first crediting period, the project has entered into the electricity generation phase on 12/11/2011 with a generation capacity of 4.8 MW.

It is estimated that the project will reduce an annual average of **294,903 tCO_2e** and a total GHG emission reductions of **2,064,322 tCO_2e** for the second crediting period.

The contributions of the project to sustainable development are:

1) Reducing global climate change by destroying the CH_4 captured from Huaycoloro's LFG.
2) Bringing the possibility for renewable energy generation capacity, offsetting the use of non-renewable resources (coal, oil, and gas); thereby displacing emissions of CO_2, a basic contributor to global warming.
3) Reducing possible health risks by destroying most of the non- CH_4 organic compounds, mainly volatile organic compounds ("VOCs") and hazardous air pollutant ("HAPs"), that are present in Huaycoloro's LFG.
4) Reducing landfill odours by combusting the LFG and improving safety by reducing explosion hazards from LFG accumulation.
5) Creating jobs associated with the design, construction, and operation of the LFG capture - much of the construction and development funding is to be spent locally for drilling, piping, construction, and operational personnel.
6) Bringing economic development near the landfill, by making the area around the project site a better and safer place to live and do business.

[4] Based on the industry standard "LFGE Project Development Handbook" of the EPA's Landfill Methane Outreach Program (LMOP) in its page 4-4 in Chapter 4 (available at http://www.epa.gov/lmop/documents/pdfs/pdh_chapter4.pdf).

[5] In the initial operation, 142 vertical extraction wells are currently installed and connected by 9,700 meters of HDPE pipe. It is expected that future extensions to collect biogas from new areas of provision will require approximately six new wells each year , the wells that are inefficient or damaged are repaired or replaced.

A.2. Location of project activity
A.2.1. Host Party(ies)
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Peru.

A.2.2. Region/State/Province etc.
>>
Lima/Huarochiri Province.

A.2.3. City/Town/Community etc.
>>
Chaclla City/San Antonio District/Huaycoloro Valley

A.2.4. Physical/Geographical location
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The project is located over the Huaycoloro Landfill; in the Km 7 the Huaycoloro Valley, in the San Antonio District, in the City of Chaclla, in the Huarochiri Province, in the Department of Lima (capital of Peru). The coordinates are Latitude: -11.931761 and Longitude: -76.872065.

Figure 2. Physical/geographical location of the project activity

A.3. Technologies and/or measures

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During the first crediting period, the project has 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.

The project was the first of its kind in Peru when was firstly validated. Huaycoloro's LFG was expected to be used as a fuel source for a 5.74 MW[6] electricity generation system; the LFG that would not be fed into the electricity generators will be flared[7]. The project activity has implemented a 4.8 MW power plant (including a power house, a substation and a transmission line to interconnect to the SEIN) using biogas for electricity generation on 12/11/2011. The LFG utilization plant (an electricity generation system of 4.8 MW capacity) includes a transmission line that reaches the SEIN.

The collection system has been installed comprehensively over closed landfill areas and inactive areas of the landfill at intermediate grade[8]. The installation includes vertical extraction wells connected to high density polyethylene pipe ("HDPE") to connect the extraction well with the flare station and LFG control plant, a condensate management system[9], leachate de-watering pumps in selected extraction wells, a blower and enclosed flaring station and the LFG measuring and recording equipment. A regular program of the operation and maintenance of the gas collection system equipment has been implemented. It is expected that future well-field expansions to collect LFG from new disposal areas will require approximately 6 new wells each year of operation; wells that are inefficient or damaged will need to be repaired or replaced, the operational monitoring (recommended as part of the operation and maintenance) will check whether there is a surplus of LFG to consider installing more wells and whether leachate pumps are required in certain wells.

The project activity consists in the capture and use/destruction of landfill gas generated at Huaycoloro landfill. The capture biogas system is fully installed in all enclosed platforms at the end of the 3rd Monitoring Period, including:

- 142 vertical extraction wells for the initial operation, and it is expected that future extensions to collect biogas from new areas of provision will require approximately six new wells each year , the wells that are inefficient or damaged are repaired or replaced.
- 9,700 meters of pipe high density polyethylene (HDPE) to connect the extraction wells to transport to automated station capture and combustion of biogas (for the initial operation)
- An automated station capture and combustion of biogas provided by John Zink Company, the enclosed flare is type ZTOF.

[6] The capacity defined in the registered CDM-PDD of 5.74 MW is considered as the maximum capacity of the project but is limited to the existing auction system for the generation of renewable energy in Peru. The difference in the installed capacity of 4.8 MW and the capacity defined in the registered CDM-PDD of 5.74 MW is due to the limitation which has Petramas towards the Peruvian Government. In February 2010, PETRAMAS got the contract to supply power for 20 years to the Peruvian Government for a total of 28,294.80 MWh per year, within the framework of the "First Auction for Electric Power Supply with Renewable Energy Resources (RER) Electric System (SEIN)" conducted by OSINERGMIN, in order to use renewable energy to ensure the country's energy security. Considering the limitation for a total of 28,294.80 MWh per year, the 5.74 MW system would imply a operational time of only 4,929 hours per year (56% of yearly operational time) while the 4.8 MW system implies a operational time of 5,895 hours per year (67% of yearly operational time). Therefore, considering the limitations of the auction system, the expected operational time of the electric generators, the projected LFG generation, the unitary engine capacity used and the financial circumstances, Petramas decided to install a capacity of 4.8 MW instead of the capacity defined in the registered CDM-PDD of 5.74 MW. The plant capacity may be expanded beyond 5.74 MW depending upon the actual capture rates of methane in the future, and the other factors highlighted.

[7] The flare will provide ERs during periods of plant downtime or when LFG capture rates exceed the plant capacity.

[8] Intermediate grade is essentially an area of the landfill that will be receiving more waste in the future; it is an area that is not completely closed yet but nevertheless there is no work being performed in areas that would interfere with gas collection.

[9] Condensate forms in the LFG piping network as the warm gas cools, and it could cause operational problems if not managed properly.

A regular program of operation and maintenance of equipment for the system of biogas capture and destruction has been implemented, according to suppliers' recommendation. A condensate management system and removal of leachate through pumps in selected extraction wells has been implemented.

Prior to the project implementation there was no collection and/or destruction 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 transfers technology and the know-how to use it to the Host Country (Peru). The technology employed by the project activity is procured by a company in an Annex I country and will utilize a renewable resource in order to generate electricity while emitting no greenhouse gases.

A.4. Parties and project participants

Party involved (host) indicates a 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)
Peru (host)	Petramas S.A	No
Netherlands	International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF)	Yes
United Kingdom of Great Britain and Northern Ireland	ICECAP Carbon Portfolio Ltd.	No
Germany	Statkraft Markets GmbH	No

The CDM Consultant responsible to prepare the CDM-PDD for the second crediting period is Sergi Cuadrat from ClimaLoop.

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
B.1. Reference of methodology

As per paragraph 230 (a) of the "Clean Development Mechanism Project Standard", version 05.0, the latest approved version of a baseline and monitoring methodology applied in the original CDM-PDD of the registered CDM project activity should be used at the time of submission of the revised PDD for the renewal of the crediting period. The CDM-PDD corresponding to the first crediting period for the "Huaycoloro landfill gas capture and combustion" used the baseline and monitoring methodology ACM0001 "Consolidated methodology for landfill gas project activities" version 4, which was replaced by the consolidated methodology ACM0001, "Flaring or use of landfill gas"(version 15.0.0). Since the version that is valid at the time of submission of the revised PDD for the renewal of the crediting period is the ACM0001, "Flaring or use of landfill gas"(version 15.0.0), this is the one that will be used in the current CDM-PDD.

The approved baseline and monitoring methodology used for the project activity is ACM0001, "Flaring or use of landfill gas"(version 15.0.0)[10]. 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)[11]
- "Project emissions from flaring"(version 02.0.0)[12]
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1)[13]
- "Tool to calculate the emission factor for an electricity system" (version 4.0)[14]
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 02.0.0)[15]
- "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)[16]
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (version 02)[17]
- "Tool to determine the remaining lifetime of equipment" (version 01)[18]

B.2. Applicability of methodology

The methodology ACM0001 "Flaring or use of landfill gas"(version 15.0.0) is applicable to project activities which:

(a) Install a new LFG capture system in a new or existing SWDS; 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 can not 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;[19] 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 15.0.0) are met by the project activity:

[10] http://cdm.unfccc.int/methodologies/DB/RIV3EXJQG8UUTER1ZYGCLIF7BP4YNT
[11] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v6.0.0.pdf/history_view
[12] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf/history_view
[13] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf/history_view
[14] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf/history_view
[15] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v1.pdf/history_view
[16] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v1.pdf/history_view
[17] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf
[18] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf
[19] For claiming emission reductions for other heat generation equipment (including other products in kilns), project participants may submit a revision to this methodology.

(a) At the validation of the project activity, the existent legislation of Solid Waste Management (SWM) in Peru, ruled by the national law 27314 on Solid Waste ("General Law of Solid Residues") gave the requirement of final solid waste disposal in the landfill. Under such legislation, there was not a specific requirement for the collection and combustion of LFG. Articles 87 and 88 of this law set minimum installations and operating conditions for landfills, respectively, (including LFG control and LFG evacuation chimneys) but it does not give any regulatory percentage of the LFG to be controlled. Furthermore, venting wells, without any flaring (which would not destroy any CH4 but avoid explosions) is not directly prohibited in this law. Therefore, prior to the implementation of the project activity, the LFG was mostly vented to the atmosphere.

At the time of the renewal of the crediting period, the Law No 27314 "Ley General de Residuos Solidos" issued in July 21, 2000[20] and the corresponding Decree No. 057-04- PCM issued in July 24, 2004[21] are still applicable. This regulation defines responsibilities regarding waste management, as well as the specifications for environmental protection in the selection, operation, monitoring and closure of final disposal sites for MSW. LFG is mentioned in Decree No. 057-04- PCM in article 85 "Minimal Installation of a Landfill", where paragraph 3 states that a landfill should have drainage and ventilation shafts and gases control but it does not stipulate any regulatory percentage of the LFG to be controlled. Furthermore, under the Law, venting wells without any flaring (which would not destroy any CH4 but simply avoid explosions) are not directly prohibited.

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 the installation of a new LFG capture system in the existing SWDS, so the application of the methodology is met by the project activity corresponding to the applicability criteria (a) set above.

(b) There was not an existing LFG capture system at the time of validation so no investment into such existing LFG capture system was made to increase the recovery rates and therefore applicability criteria (b) set above is not met by the project activity.

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

    (i) The project activity in Huaycoloro is expected to generate electricity so the applicability criteria (c) (i) is applicable to the project activity.

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

    (iii) The project activity in Huaycoloro will not supply the LFG to consumers through a natural gas distribution network so the applicability criteria (c) (iii) is 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 in Huaycoloro will not reduce the amount of organic waste that would be recycled in the absence of the project activity so the project meets the applicability criteria (d).

[20] http://www.digesa.sld.pe/NormasLegales/Normas/ley_general.pdf
[21] http://www.digesa.sld.pe/NormasLegales/Normas/DS_057_2004_PCM_2.pdf

Moreover, the methodology ACM0001 "Flaring or use of landfill gas"(version 15.0.0) is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:

(a) Release of LFG from the SWDS; 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 collection and/or destruction 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 meets the applicability criteria (a) above) and power generation using existing and/or new grid-connected power plants (so the project meets the applicability criteria (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) so the stepwise procedure has been followed to assess the continued validity of the baseline.

Finally, the methodology ACM0001 "Flaring or use of landfill gas"(version 15.0.0) is not applicable:

(a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;

(b) If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.

The above conditions are not applicable to the project activity as clarified below:

(a) The project activity will not apply in combination with other approved methodologies, and 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 15.0.0) is applicable for the project activity.

(b) The project activity will not change 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 15.0.0) is applicable for the project activity.

The following paragraphs describe how each of the applicability conditions of the latest versions of the following 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 Huaycoloro Landfill. 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 the ACM0001 "Flaring or use of landfill gas"(version 15.0.0).

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) is applicable for the purpose of calculating project emissions in case where 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, then the tool is applicable.

- "Tool to calculate the emission factor for an electricity system" (version 4.0) is applicable as required by the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) for the purpose of calculating project and leakage emissions in case where a 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, then the tool 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 to determine to determine the mass flow of greenhouse gases such CO2, CH4, N2O, SF6 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 the present project activity, and 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.
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (version 02) is applicable to calculate project and/or leakage CO2 emissions from the combustion of fossil fuels. The type(s) of fossil fuel(s) to be used will depend on the choice of the developer (i.e. natural gas, fuel oil, diesel, etc.) to develop the project activity. For the current project activity, since the quantity of fuel combusted and its properties are monitored, then the tool is applicable.
- "Tool to determine the remaining lifetime of equipment" (version 01) may be used for project activities which involve the replacement of existing equipment with new equipment. At the renewal of the crediting period, the replacement of existing equipment is not applicable although it might be applicable in due course.

B.3. Project boundary

As per methodology ACM0001 "Flaring or use of landfill gas"(version 15.0.0), the project boundary of the project activity shall include the site where the LFG is captured and, as applicable:

- Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln or natural gas distribution network);

- Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity;
- Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity in the baseline that is displaced by electricity generated by captured LFG in the project activity; and
- Heat generation equipment or sources which are supplying heat in the baseline that is displaced by heat generated by captured LFG in the project activity.

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
		CO_2	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative
		N_2O	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
	Emissions from flaring	CO_2	No	Emissions are considered negligible
		CH_4	Yes	May be an important emission source
		N_2O	No	Emissions are considered negligible

In addition to the table, a flow diagram of the project boundary, physically delineating the project activity is presented, 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 15.0.0), as follows:

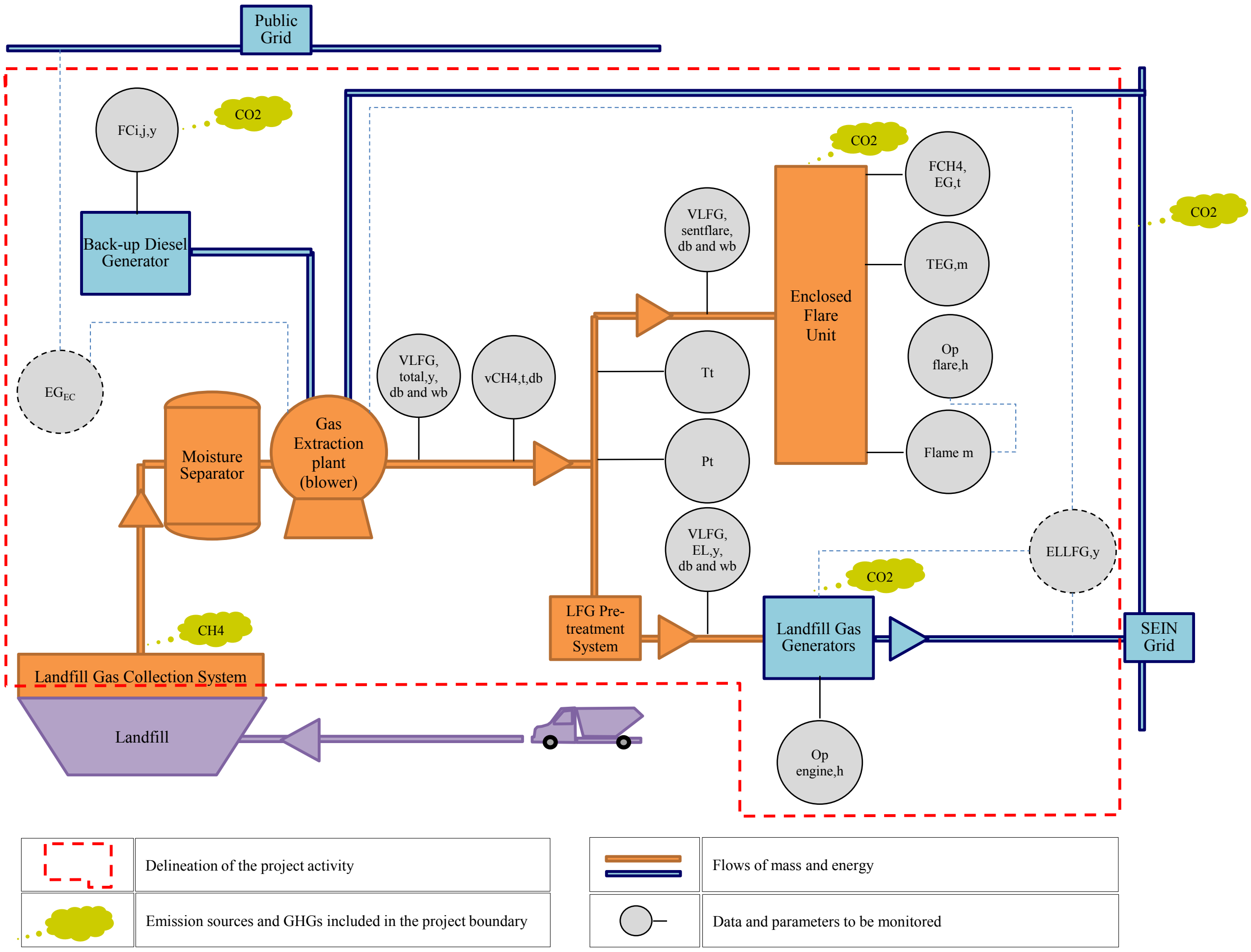

Figure 3. Flow diagram of the project boundary

B.4. Establishment and description of baseline scenario

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As per paragraph 230 (a) of the "Clean Development Mechanism Project Standard", version 05.0, the latest approved version of a baseline and monitoring methodology applied in the original CDM-PDD of the registered CDM project activity should be used at the time of submission of the revised PDD for the renewal of the crediting period. The CDM-PDD corresponding to the first crediting period for the "Huaycoloro landfill gas capture and combustion" used the baseline and monitoring methodology ACM0001 "Consolidated methodology for landfill gas project activities" version 4, which was replaced by the consolidated methodology ACM0001, "Flaring or use of landfill gas"(version 15.0.0). Since the version that is valid at the time of submission of the revised PDD for the renewal of the crediting period is the ACM0001, "Flaring or use of landfill gas"(version 15.0.0), this is the one that will be used in the current CDM-PDD.

Additionally, as per paragraph 231 of the "Clean Development Mechanism Project Standard", version 05.0, to demonstrate the validity of the original baseline, project participants are not required to re-assess the baseline scenario. Instead, project participants shall assess the GHG emission reductions that would have resulted from that scenario.

As required by the "Clean Development Mechanism Project Standard", version 05.0, 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) so the stepwise procedure is followed to assess the continued validity of the baseline, as follows:

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

If 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, go to Step 1.2.

At the validation of the project activity, the existent legislation of Solid Waste Management (SWM) in Peru, ruled by the national law 27314 on Solid Waste ("General Law of Solid Residues") gave the requirement of final solid waste disposal in the landfill. Under such legislation, there was not a specific requirement for the collection and combustion of LFG. Articles 87 and 88 of this law set minimum installations and operating conditions for landfills, respectively, (including LFG control and LFG evacuation chimneys) but it does not give any regulatory percentage of the LFG to be controlled. Furthermore, venting wells, without any flaring (which would not destroy any CH_4 but avoid explosions) is not directly prohibited in this law. Therefore, prior to the implementation of the project activity, the LFG was mostly vented to the atmosphere and 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 national law 27314 on Solid Waste ("General Law of Solid Residues") still applies.

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. 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 the Step 1.2 is followed.

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

In accordance to the report[22] of the current situation of solid waste management in Peru elaborated by the Peruvian Ministry of Environment, in Peru there are only10 landfills and 5 of them are located in Lima Region which receives 92% of the MSW of Lima. The other five landfills are spread in the provinces and a other The table below, prepared based in the report made by the Ministry of Environment, present the list of landfills located in Peru identifying the ones which have installed a collection and flaring system and the ones which are CDM projects:

Landfill Name	Collection and flaring of methane from the landfill?	CDM Project?
Zapallal	No	No
Portillo Grande	No	No
Callao	Yes	Yes
Huaycoloro	Yes	Yes
Ancón[23]	Yes	Yes

As can be seen above, the landfills of Callao, Huaycoloro and Ancón are the only ones in the country which have installed a collection and flaring system and, at the same time, are CDM projects. At the time of validation of the project activity, Huaycoloro was the first of its kind since no similar activities were implemented in Peru ever before. 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 Peru.

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.

[22] Ministerio de Ambiente "Informe de la Situación Actual de la Gestión de residuos Sólidos Municipales" October 2008. Page 15. http://www.redrrss.pe/material/20101021014024.pdf

[23] At the time of renewal of the crediting period, the Ancón project has been closed due to contamination according to http://www.larepublica.pe/29-09-2011/clausuran-un-relleno-sanitario-de-ancon

Since there have not been any updates that have come into effect after the submission of the project activity for validation in respect of the requirement to capture and flare LFG at the start of the second crediting period by any mandatory law, there is no impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions. Moreover, the conditions used to determine the baseline emissions in the previous crediting period are still valid for the renewal of the crediting period.

> **Outcome of step 1.2:** ***Since the circumstances make a continued validity of the current baseline, then the current baseline does not need to be updated for the subsequent crediting period under this step.***

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 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.

> **Outcome of step 1.3:** ***Since the baseline scenario identified at the validation of the project activity was not the continuation of use of the current equipment(s) because it required investment, 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 can not 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 Huaycoloro landfill, a first-order decay equation identical to the algorithm in the U.S. Environmental Protection Agency (USEPA) landfill gas emissions model LandGEM ("USEPA model") was used. The USEPA model requires that the site's waste disposal history (or, at a minimum, the amount of waste in place and opening date) be known. The USEPA model employs a first-order exponential decay function, which assumes that LFG generation is at its peak following a time lag representing the period prior to CH4 generation. The USEPA model assumes a one-year time lag between placement of waste and LFG generation. After one year, the model assumes that LFG generation decreases exponentially as the organic fraction of waste is consumed.. At that time, the methodology ACM0001 "Consolidated baseline methodology for landfill gas project activities" version 4, only had two explicit parameters to be determined at the start of the crediting period:

- GWP Factor Used for Converting Methane to Carbon Dioxide Equivalents: 21 tCO2e/tCH4.
- Methane Density at standard temperature and pressure (0 degree Celsius and 1,013 bar): 0.0007168 tCH4/m3CH4.

For the renewal of the crediting period, the approved baseline and monitoring methodology used is ACM0001 "Flaring or use of landfill gas"(version 15.0.0), 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 USEPA model. However, the GWP of methane has been updated from 21 (1st crediting period) to 25 (2nd crediting period) as per Table 2.14 of the Fourth Assessment Report of the IPCCC[24]..

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 it has been proceed to Step 2.

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

This step is only applicable if any of the Steps 1.1, 1.2, 1.3 and/or 1.4 showed that the current baseline needs to be updated.

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 15.0.0). 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 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 15.0.0).

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 to be the same as that for the registered CDM-PDD corresponding to the first crediting period.

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[24] As per COP Decision 4/CMP.7, *“for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled “Global Warming Potential for Given Time Horizon” in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, taking into account the inherent and complicated uncertainties involved in global warming potential estimates”*. Therefore, GWP of methane has been updated from 21 (1st crediting period) to 25 (100-year time horizon) as per Table 2.14 of the Fourth Assessment Report of the IPCCC.

In the registered CDM-PDD corresponding to the first crediting period applying ACM0001 "Consolidated baseline methodology for landfill gas project activities" version 4, it was demonstrated that the project's equity IRR resulted in a -4.0%, while the minimum equity IRR for the sponsor (benchmark) was 14%. Since the CDM project activity had a less favourable indicator than the benchmark, then the project activity was not considered financially attractive without the CDM revenues at the time of validation. It was assumed that generation by the grid (the baseline scenario) was financially more attractive than generation by the project.

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 to be the same for the second crediting period.

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 the ACM0001 "Flaring or use of landfill gas"(version 15.0.0)

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:[25]

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

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*

[25] $OX_{top-layer}$ 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.

(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:

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

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 15.0.0)**

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 $Op_{flare,h,y}$).

$F_{CH4,flared,y}$ 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 $F_{CH4,HG,y\ y}$ 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 gases 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:

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

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 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 $F_{CH4,sent\_flare,y}$ 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” V.2.0.0.* Measured flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option B.1 of “Project emissions from flaring” version 02.0.0. Under Option B.1 the measurement is conducted by an accredited entity on a biannual basis.

Default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex ante as per Option A of “Project emissions from flaring” version 02.0.0 and in case that under Option B.1, the measurement cannot be conducted by an accredited entity on a biannual basis ex post. The flare height installed in the project activity is more than 10 times the diameter. This makes it a high 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 not using a low height flare, the flare efficiency in the minute m shall not be adjusted by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 90% will be used for the project activity to calculate the amount of methane destroyed by flaring ex ante.

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 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 $F_{CH4,m}$, 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;
- CH4 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. For determining the efficiency of combustion of enclosed flares there is the option to apply a default value or determine the efficiency based on monitored data. For open flares a default value must be applied. The time the flare is operating is determined by monitoring the flame using a flame detector and, for the case of enclosed flares, in addition the monitoring requirements provided by the manufacturer's specifications for operating conditions shall be met.

Open flare

In the case of open flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) is 50% when the flame is detected in the minute *m* ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%.

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%.

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 ($Flame_m$).

Otherwise $\eta_{flare,m}$ is 0%.

Default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex ante as per Option A of "Project emissions from flaring" version 02.0.0. The flare height installed in the project activity is more than 10 times the diameter. This makes it a high 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 not using a low height flare, the flare efficiency in the minute m shall not be adjusted by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 90% will be used for the project activity to calculate the amount of methane destroyed by flaring ex ante.

Option B: Measured flare efficiency

The flare efficiency in the minute *m* is a measured value ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following three 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;

(2) The flame is detected in minute m ($Flame_m$); and

Otherwise $\eta_{flare,m}$ is 0%.

In applying Option B, the project participants may choose to determine $\eta_{flare,calc,m}$ using either Option B.1 or Option B.2. Under Option B.1 the measurement is conducted by an accredited entity on a biannual basis and under Option B.2 the flare efficiency is measured in each minute.

Option B.1: Biannual measurement of the flare efficiency

For the determination ex post in the project activity, measured flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option B.1 of "Project emissions from flaring" version 02.0.0. Under Option B.1, the measurement is conducted by an accredited entity on a biannual basis.

The calculated flare efficiency ($\eta_{flare,calc,m}$) is determined as the average of two measurements of the flare efficiency made in year y ($\eta_{flare,calc,y}$), as follows:

$$\eta_{flare,calc,y} = 1 - \frac{1}{2}\sum_{t=1}^{2}\left(\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}}\right)$$

Tool equation (1)

Variable	*Description*
$\eta_{flare,calc,y}$	Flare efficiency in the year y
$F_{CH4,EG,t}$	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t (kg)
$F_{CH4,RG,t}$	Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period t (kg)
t	The two time periods in year y during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months

$F_{CH4,EG,t}$ is measured according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated according to Step 1, and consists of the sum of methane flow in the minutes *m* that make up the time period *t*.

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:

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

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)
$p_{H20,t,Sat}$	=	Amount of methane in the LFG which is sent to the flare in year y (t CH4/yr)
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, O2, CO, H2, CH_4, N_2O, NO, NO2, 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 the methodology ACM0001 version 15.0.0 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 (CH4) 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 doable 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 (CH2O,t,db,n) and demonstrate that this is less or equal to 0.05 kg H2O/m3 dry gas; or

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

For the project activity, the way b) from above will be used so it will be demonstrated that the temperature of the gaseous stream (Tt) 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 actibity 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 (m³ 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 (m³ gas *i*/m³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m³ 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.m3/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 (m³ dry gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m³ wet gas/h)
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)

The volumetric fraction of H2O 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:

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

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_j	=	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 15.0.0:
y		Year for which methane emissions are calculated

Since ACM0001, Version 15.0.0: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 in this occasion.

ACM0001 Version 15.0.0: 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* (*DOCj*);
- 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 Wj,x

= Wx and Wj,i = Wi 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 activity 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 data

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

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

In this situation:

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

Case 2: Requirement to destroy methane exists and no existing LFG capture system

In this situation:

$$F_{CH4,BL,y} = F_{CH4,BL,R,y} \quad \textbf{(7)}$$

$F_{CH4,BL,R,y}$ should be determined based on the information contained in the requirement to destroy methane, as follows:

a) If the requirement specifies the amount of methane that must be flared then that amount is $F_{CH4,BL,R,y}$;

b) If the requirement specifies a percentage of the LFG that is required to be flared, the amount shall be calculated as follows:

$$F_{CH4,BL,R,y} = \rho_{reg,y} \times F_{CH4,PJ,capt,y} \quad \textbf{(8)}$$

Where:

$F_{CH4,BL,R,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (t CH_4/yr)
$\rho_{reg,y}$	=	Fraction of LFG that is required to be flared due to a requirement in year *y*
$F_{CH4,PJ,capt,y}$	=	Amount of methane in the LFG which is captured in the project activity in year *y* (t CH_4/yr)

Project participants may choose to calculate $F_{CH4,PJ,capt,y}$ by either of the two options:

Option 1: Calculate using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", applying the following requirements:

- The gaseous stream the tool shall be applied to is the LFG pipeline immediately downstream of the LFG capture system and before any split in the gaseous flow to different uses or flares;
- CH_4 is the greenhouse gases 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); and
- The mass flow should be calculated on an hourly basis for each hour *h* in year *y*.

Option 2: Calculate as the sum of the amount of methane that is sent to the flare, electricity generating or heat generating equipment in year *y* as measured in Step A.1, however not taking into account the working hours of the equipment.

c) If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$$F_{CH4,BL,R,y} = 0 \quad \textbf{(9)}$$

d) If the requirement does not specify any amount or percentage of LFG that should be destroyed but requires the installation of a system to capture and flare the LFG, then a typical destruction rate of 20% is assumed:[26]

$$F_{CH4,BL,R,y} = 0.2 \times F_{CH4,PJ,capt,y} \quad \textbf{(10)}$$

Case 3: No requirement to destroy methane exists and a LFG capture system exists

In this situation:

$$\mathrm{F_{CH4,BL,y} = F_{CH4,BL,sys,y}} \quad \textbf{(11)}$$

- If the amount of methane captured with the existing system can be monitored separately from the amount captured under the project, and the efficiency of the existing system is not impacted on by the project system during the crediting period(s), then $\mathrm{F_{CH4,BL,sys,y}}$ is determined as follows:

$$F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y} \quad \textbf{(12)}$$

Where:

$\mathrm{F_{CH4,BL,sys,y}}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (t CH_4/yr)
$\mathrm{F_{CH4,sent\_flare,y}}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)

$\mathrm{F_{CH4,sent\_flare,y}}$ is determined using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" and applying the requirements described in Step A.1, where the gaseous

[26] This default value of 20% is based on assuming a situation in which: the efficiency of the LFG capture system in the project is 50%; the efficiency of the LFG capture system in the baseline is 20%; and, the amount captured in the baseline is flared using an open flare with a destruction efficiency of 50% (consistent with the default value provided in the "Tool to determine project emissions from flaring gases containing methane"). Project participants may propose and justify an alternative default value as a request for revision to this methodology.

stream the tool shall be applied to is the pipeline collecting LFG from the existing LFG capture system.

- If there is no monitored data available, but there is historic data on the amount of methane that was captured in the year prior to the implementation of the project activity, then in this situation:

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y} \quad \textbf{(13)}$$

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y} \quad \textbf{(14)}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (t CH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (t CH_4/yr)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (t CH_4/yr)
$F_{CH4,PJ,capt,y}$	=	Amount of methane in the LFG which is captured in the project activity in year *y* (t CH_4/yr)

$F_{CH4,x-1}$ shall be estimated using the methodological tool "Emissions from solid waste disposal sites". The guidance and requirements described in Step A.1.1 for applying the tool shall be followed. The year *y* in the tool is equivalent to the year prior to the implementation of the project activity.

- If there is no monitored or historic data on the amount of methane that was captured in the year prior to the implementation of the project situation, then:

$$F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y} \quad \textbf{(15)}$$

The 20% default factor is consistent with the default factor given in equation 10.

Case 4: Requirement to destroy methane exists and LFG capture system exists

$F_{CH4,BL,y}$ shall be determined based on information in contract of regulation requirements and data related to the existing LFG capture system, as follows:

$$F_{CH4,BL,y} = \max\left\{F_{CH4,BL,R,y};\quad F_{CH4,BL,sys,y}\right\} \quad \textbf{(16)}$$

Where:

$F_{CH4,BL,R,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (t CH_4/yr)
$F_{CH4,BL.sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (t CH_4/yr)

$F_{CH4,BL,R,y}$ and $F_{CH4,BL.sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3 above.

For the project activity, the Case 2 "Requirement to destroy methane exists and no existing LFG capture system" under situation c) "the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared" is applicable because the legislation applicable at the submission for validation of the project activity does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG and without existing LFG capture system. At the validation of the project activity, the existent legislation of Solid Waste Management (SWM) in Peru, ruled by the national law 27314 on Solid Waste ("General Law of Solid Residues") gave the requirement of final solid waste disposal in the landfill. Under such legislation, there was not a specific requirement for the collection and combustion of LFG. Articles 87 and 88 of this law set minimum installations and operating conditions for landfills, respectively, (including LFG control and LFG evacuation vents) but it does not give any regulatory percentage of the LFG to be controlled. Furthermore, venting wells, without any flaring (which would not destroy any CH4 but avoid explosions) is not directly prohibited in this law. Therefore, prior to the implementation of the project activity, the LFG was mostly vented to the atmosphere and 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.

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 as per Equation 9, under Case 2 c) as follows:

$$F_{CH4,BL,R,y} = 0 \qquad \mathrm{F_{CH4,BL,y}} = 0$$

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
- $EC_{BL,k,y}$ 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 ($EL_{LFG,y}$)

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.

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:

$$PE_y = PE_{EC,y} + PE_{FC,y} \tag{17}$$

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)

The project emissions from consumption of electricity by the project activity (PEEC,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:

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

$\mathbf{PE_{EC,y}}$	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),
$\mathbf{EF_{grid,y}}$	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 scenario A: Electricity consumption from the grid option A1 was choose for the determination of the emission factors for electricity generation ($EF_{EL,j/k/l,y}$). The combined margin emission factor of the applicable electricity system is estimated using the procedures of the latest approved version of the. "*Tool to calculate the emission factor for an electricity system*"*V.4.0*. ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$) as shown in Appendix 3: Applicability of selected methodology.

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" (version 02). When applying the tool:

- Processes *j* in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars;
- If in the baseline a proportion of LFG is captured and flared ($F_{CH4,BL,y}$> 0), then the fossil fuels consumption used in calculation ($FC_{i,j,y}$) should refer to the net of that consumed in the baseline. The determination of the amount of fossil fuels consumed in the baseline shall be transparently documented in the CDM-PDD.
- $\mathbf{E_{FC,y}}$ will be calculated using the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". V.2.*

Tool to calculate project or leakage CO2 emissions from fossil fuel combustion. V.2"

CO2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \textbf{(1)}$$

Where:

$\mathbf{PE_{FC,i,y}}$	CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$\mathbf{FC_{i,j,y}}$	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);
$\mathbf{COEF_{i,y}}$	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2 / mass or volume unit); **i** are the fuel types combusted in process *j* during the year *y*.

The CO_2 emission coefficient $COEF_{i,y}$ will be calculated using option B based on net calorific value and CO_2 emission factor of the fuel(s) type(s) used. Option A can not be applied because the necessary data is not available.

The type(s) of fossil fuel(s) to be used will depend on the choice of the developer (i.e. natural gas, fuel oil, diesel, etc.), and the corresponding emission factors will be taken from the IPCC 2006 default values, in case there is no data available.

Leakage

No leakage effects are accounted for under this methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(18)}$$

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

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	Consistent with how oxidation is accounted for in the methodological tool “Emissions from solid waste disposal sites”
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.

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	25 for the second commitment period in accordance with Table 2.14 of the Fourth Assessment Report of the IPCCC. Shall be updated according to any future COP/MOP decisions.
Purpose of data	Calculation of baseline emissions
Additional comment	As per COP Decision 4/CMP.7, *“for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled “Global Warming Potential for Given Time Horizon” in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, taking into account the inherent and complicated uncertainties involved in global warming potential estimates”.* Therefore, GWP of methane has been updated from 21 (1st crediting period) to 25 (100-year time horizon) 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	IPCC
Value(s) applied	0.0007168
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	$BE_{CH4, SWDS,y}$
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

Start year	$BE_{CH4,SWDS,y}$ (t CO_2e)
2013	556,527
2014	574,287
2015	591,586
2016	608,490
2017	625,057
2018	641,337
2019	657,374
Total	**4,254,657**

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><td></td><td>Humid/wet conditions</td><td>Dry conditions</td></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 N/AtioN/Al 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**
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
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 be flared and/or used for electricity.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	η_{PJ}
Unit	-
Description	The efficiency of the degassing system which will be installed in the project activity, in year y
Source of data	As per ACM0001 / Version 15.0.0 "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 page 10/23 of ACM0001 / Version 15.0.0 "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	**OX**
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	As per the "*Emissions from solid waste disposal sites".V6.*
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	N/A

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 is "for unmanaged solid waste disposal sites - deep and/or with high water table. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

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

Data / Parameter	**DOC_f**
Unit	-
Description	Fraction of degradable organic carbon (DOC) that can decompose
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 Nationall 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 Huaycoloro Landfill is located in Peru (Lima), which has a mean annual temperature (MAT) of 19.4ºC and mean annual precipitation (MAP) of 13 mm. Data on potential evapotranspiration (PET) is 1. Therefore, the site is based in a Tropical/Temperate climatic conditions (MAT>20C) and dry 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/029/c00108.htm</td></tr>
</table>

Data / Parameter	**$EF_{grid,y}$**
Unit	tCO2/MWh
Description	Emission factor for electricity generation
Source of data	Calculated as per the ”Tool to calculate the emission factor for an electricity system” Version 4.0. See detailed calculation in sheets provided to DOE
Value(s) applied	0.45338
Choice of data or Measurement methods and procedures	Calculated as per the ”Tool to calculate the emission factor for an electricity system” Version 4.0
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	0.9
Choice of data or Measurement methods and procedures	Measured flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option B.1 of “Project emissions from flaring” version 02.0.0. Under Option B, the project participant has chosen to determine flare efficiency using Option B.1. Under Option B.1 the measurement is conducted by an accredited entity on a biannual basis.
Purpose of data	Calculation of Baseline emissions
Additional comment	The default value flare efficiency will be used to calculate the amount of methane destroyed by flaring ex ante as per Option A (1) of “Project emissions from flaring” version 02.0.0. For ex ante estimation of FCH4,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 "Emissions from solid waste disposal sites" (Version 06.0.1). The flare height installed in the project activity is more than 10 times the diameter. This makes it a high 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 not using a low height flare, the flare efficiency in the minute m shall not be adjusted by subtracting 0.1 from the default value of 90% for the efficiency of the flare. Therefore, a value of 90% will be used ex-ante for the project activity.

Data / Parameter	TDL_y
Unit	%
Description	Average technical transmission and distribution losses in the grid in year y.
Source of data	Default value of average technical transmission and distribution losses will be used.
Value(s) applied	20.0%
Choice of data or Measurement methods and procedures	Not applicable
Purpose of data	Calculation of baseline emissions and Calculation of project emissions
Additional comment	Determined ex ante for the second monitoring period.

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - °C Flow rate - Nm3/h Maintenance schedule - number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	Temperature - From 760 to 982°C (1400 °F to 1800 °F)[27] Flow rate - From 643 to 6,430 Nm3/h (400[28] SCFM to 4,000 SCFM[29]) Maintenance schedule – Weekly (7 days)[30]
Choice of data or Measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare are: (a) From 643 to 6,430 Nm3/h inlet flow rate; and (b) From 760 to 982°C operating temperature (c) Maximum of 7 days between maintenance events.
Purpose of data	Not used in emission reductions calculations.
Additional comment	Only applicable in case of enclosed flares. The maintenance schedule is not required if Option A is selected to determine flare efficiency of an enclosed flare

[27] Operating temperature as per manufacturer's flare specifications set in page 12 of the document provided to the DOE under the name "Manual John Zink_ ZTOF"

[28] Considering a 50% methane concentration, all flares designed for flow rates of 1500 SCFM (2411 Nm3/h) or greater must achieve a 10:1 instantaneous turndown minimum as set in point 1.03.A.2 of the manufacturer's flare specifications provided to the DOE under the name "ZTOF_Landfill Gas Enclosed Flare System". Therefore, the minimum inlet flow rate of the flare would be 400 SCFM (643 Nm3/h).

[29] The maximum inlet flow rate is 4,000 SCFM as per manufacturer's flare specifications set in page 12 of the document provided to the DOE under the name "Manual John Zink_ ZTOF"

[30] The maintenance program should be developed by the user of the flare as per manufacturer's flare specifications set in page 29 of the document provided to the DOE under the name "Manual John Zink_ ZTOF", and that is why a maximum of 7 days between maintenance events are considered appropriate by the project developer.

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 the equation (2) for the ACM0001 Version 15.0.0:

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

Period			BE_{CH4} (tonnes of CO2)
Period Year	Start Date	End Date	
8	15/03/2014	14/03/2015	251,130
9	15/03/2015	14/03/2016	259,794
10	15/03/2016	14/03/2017	266,797
11	15/03/2017	14/03/2018	274,357
12	15/03/2018	14/03/2019	281,769
13	15/03/2019	14/03/2020	289,867
14	15/03/2020	14/03/2021	296,238
Total			**1,919,952**
Annual average			**274,279**

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)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	556,527
9	15/03/2015	14/03/2016	574,287
10	15/03/2016	14/03/2017	591,586
11	15/03/2017	14/03/2018	608,490
12	15/03/2018	14/03/2019	625,057
13	15/03/2019	14/03/2020	641,337
14	15/03/2020	14/03/2021	657,374
Total			**4,254,657**
Annual average			**607,808**

The next table contains the $F_{CH4,PJ,y}$ values obtained from the application of the equation (5) for the ACM0001 Version 15.0.0::

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

Period			$F_{CH4,PJ,y}$ (tonnes of CH4)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	11,161
9	15/03/2015	14/03/2016	11,546
10	15/03/2016	14/03/2017	11,858
11	15/03/2017	14/03/2018	12,194
12	15/03/2018	14/03/2019	12,523
13	15/03/2019	14/03/2020	12,883
14	15/03/2020	14/03/2021	13,166
Total			**85,331**
Annual average			**12,190**

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

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) have been calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" considering the electricity capacity installed of 4,8 MW. The following table summarizes the results:

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

Period			$BE_{EC,y}$ (tonnes of CO2)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	20,892
9	15/03/2015	14/03/2016	20,892
10	15/03/2016	14/03/2017	20,892
11	15/03/2017	14/03/2018	20,892
12	15/03/2018	14/03/2019	20,892
13	15/03/2019	14/03/2020	20,892
14	15/03/2020	14/03/2021	20,892
Total			**146,244**
Annual average			**20,892**

The above results are based on the results below:

Table 5. Annual calculation for $ELE_{LFG,y}$

Period			$ELE_{LFG,y}$ (MWh)
Period Year	Start Date	End Date	
8	15/03/2014	14/03/2015	38,400
9	15/03/2015	14/03/2016	38,400
10	15/03/2016	14/03/2017	38,400
11	15/03/2017	14/03/2018	38,400
12	15/03/2018	14/03/2019	38,400
13	15/03/2019	14/03/2020	38,400
14	15/03/2020	14/03/2021	38,400
Total			**268,800**
Annual average			**38,400**

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 tables below contains the BE_y values obtained from the application of the equation (1) for the ACM0001 Version 15.0.0:

Table 6. Annual calculation for BE_y

Period			BE_y (tCO2e)
Period Year	Start Date	End Date	
8	15/03/2014	14/03/2015	272,022
9	15/03/2015	14/03/2016	280,686
10	15/03/2016	14/03/2017	287,689
11	15/03/2017	14/03/2018	295,249
12	15/03/2018	14/03/2019	302,661
13	15/03/2019	14/03/2020	310,759
14	15/03/2020	14/03/2021	317,130
Total			**2,066,196**
Annual average			**295,171**

Project emissions

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)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	268
9	15/03/2015	14/03/2016	268
10	15/03/2016	14/03/2017	268
11	15/03/2017	14/03/2018	268
12	15/03/2018	14/03/2019	268
13	15/03/2019	14/03/2020	268
14	15/03/2020	14/03/2021	268
Total			**1,876**
Annual average			**268**

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)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	0
9	15/03/2015	14/03/2016	0
10	15/03/2016	14/03/2017	0
11	15/03/2017	14/03/2018	0
12	15/03/2018	14/03/2019	0
13	15/03/2019	14/03/2020	0
14	15/03/2020	14/03/2021	0
Total			**0**
Annual average			**0**

The project emissions in the project activity are calculated as per equation (21) of the ACM0001 Version 15.0.0, with the following results:

Table 9. Annual calculation for PEy

Period			PE_y (tCO2)
Period Year	**Start Date**	**End Date**	
8	15/03/2014	14/03/2015	268
9	15/03/2015	14/03/2016	268
10	15/03/2016	14/03/2017	268
11	15/03/2017	14/03/2018	268
12	15/03/2018	14/03/2019	268
13	15/03/2019	14/03/2020	268
14	15/03/2020	14/03/2021	268
Total			**1,876**
Annual average			**268**

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 (25) of the ACM0001 Version 15.0.0:, 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)
8	272,022	268	0	271,755
9	280,686	268	0	280,418
10	287,689	268	0	287,421
11	295,249	268	0	294,981
12	302,661	268	0	302,394
13	310,759	268	0	310,491
14	317,130	268	0	316,862
Total	**2,066,196**	**1,876**	**0**	**2,064,322**
Total number of crediting years	7 years			
Annual average over the crediting period	**295,171**	**268**	**0**	**294,903**

B.7. Monitoring plan
B.7.1. Data and parameters to be monitored

Data / Parameter	**Management of SWDS**
Unit	-
Description	Management of SWDS
Source of data	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local or national regulations
Value(s) applied	-
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annually
QA/QC procedures	This section has been left in blank on purpose.
Purpose of data	Not required for calculations.
Additional comment	This section has been left in blank on purpose.

Data / Parameter	$\rho_{reg,y}$
Unit	Dimensionless
Description	Fraction of LFG that is required to be flared due to a requirement in year y
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns. For ex ante calculations, a default value of 0 has been chosen as per ACM0001 / Version 15.0.0, Step A2, Case 2 c), eq. 9
Value(s) applied	0
Measurement methods and procedures	For the project activity, the Case 2 "Requirement to destroy methane exists and no existing LFG capture system" under situation c) "the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared" is applicable because the legislation applicable at the submission for validation of the project activity does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG and without existing LFG capture system. ACM0001 / Version 15.0.0, Step A2, Case 2 c), eq. 9 is applied.
Monitoring frequency	Annually
QA/QC procedures	This section has been left in blank on purpose.
Purpose of data	Calculation of Baseline emissions.
Additional comment	Applicable to Case 2 of section-5.4.1.3. Used to calculate $F_{CH4,BL,y}$, which is part of the calculation of $BE_{CH4,y}$.

Data / Parameter	$V_{LFG,total,y,db}$
Unit	m^3 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	Measured by a flow meter
Value(s) applied	<table><tr><th>Year Period</th><th>$V_{LFG,total,y,db} = LFG_{total,y}$</th></tr><tr><td>8</td><td>31,142,147</td></tr><tr><td>9</td><td>32,216,514</td></tr><tr><td>10</td><td>33,084,974</td></tr><tr><td>11</td><td>34,022,455</td></tr><tr><td>12</td><td>34,941,648</td></tr><tr><td>13</td><td>35,945,808</td></tr><tr><td>14</td><td>36,735,843</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. The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Continuous.
QA/QC procedures	Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer's specifications.
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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used.

<table>
<tr><td>Data / Parameter</td><td>$V_{LFG,sent\_flare,y,db}$</td></tr>
<tr><td>Unit</td><td>m³ dry gas/h</td></tr>
<tr><td>Description</td><td>Volumetric flow of landfill gas which is sent to flare in year y on a dry basis</td></tr>
<tr><td>Source of data</td><td>Measured by a flow meter</td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Year Period</th><th>$V_{LFG,sent\_flare,y,db} = LFG_{flare,y}$</th></tr>
<tr><td>8</td><td>9,459,254</td></tr>
<tr><td>9</td><td>10,533,621</td></tr>
<tr><td>10</td><td>11,402,081</td></tr>
<tr><td>11</td><td>12,339,561</td></tr>
<tr><td>12</td><td>13,258,754</td></tr>
<tr><td>13</td><td>14,262,914</td></tr>
<tr><td>14</td><td>15,052,950</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required.
The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system.
The accuracy of the measurement equipment will be 1% full scale.
The responsible person/entity for the measurement will be the project participant.
The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.</td></tr>
<tr><td>Monitoring frequency</td><td>Continuous</td></tr>
<tr><td>QA/QC procedures</td><td>Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer’s specifications.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used.</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$V_{LFG,EL,y,db}$</td></tr>
<tr><td>Unit</td><td>m^3 dry gas/h</td></tr>
<tr><td>Description</td><td>Volumetric flow of landfill gas which is used for electricity generation in year y on a dry basis</td></tr>
<tr><td>Source of data</td><td>Measured by a flow meter</td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Year Period</th><th>$V_{LFG,EL,y,db} = LFG_{electricity,y}$</th></tr>
<tr><td>8</td><td>21,682,894</td></tr>
<tr><td>9</td><td>21,682,894</td></tr>
<tr><td>10</td><td>21,682,894</td></tr>
<tr><td>11</td><td>21,682,894</td></tr>
<tr><td>12</td><td>21,682,894</td></tr>
<tr><td>13</td><td>21,682,894</td></tr>
<tr><td>14</td><td>21,682,894</td></tr>
</table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required.
The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system.
The accuracy of the measurement equipment will be 1% full scale.
The responsible person/entity for the measurement will be the project participant.
The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.</td></tr>
<tr><td>Monitoring frequency</td><td>Continuous</td></tr>
<tr><td>QA/QC procedures</td><td>Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer’s specifications.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used.</td></tr>
</table>

Data / Parameter	$V_{LFG,total,y,wb}$
Unit	m^3 wet gas/h
Description	Volumetric flow of total landfill gas which is sent to flare and used for electricity generation in year y on a wet basis
Source of data	Measured by a flow meter
Value(s) applied	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
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. The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
Additional comment	This parameter will be monitored in Options B 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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used.

Data / Parameter	**$V_{LFG,sent\_flare,y,wb}$**
Unit	m^3 wet gas/h
Description	Volumetric flow of landfill gas which is sent to flare in year y on a wet basis
Source of data	Measured by a flow meter
Value(s) applied	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
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. The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
Additional comment	This parameter will be monitored in Options B 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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used. The parameter $V_{LFG,sent\_flare,y,wb}$ equates to the parameter $V_{RG,m}$ in the application of the "Project emissions from flaring" version 02.0.0.

Data / Parameter	**$V_{LFG,EL,y,wb}$**
Unit	m^3 wet gas/h
Description	Volumetric flow of landfill gas which is used for electricity generation in year y on a wet basis
Source of data	Measured by a flow meter
Value(s) applied	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
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. The measurement method will be based in the thermal principle of the thermal mass flowmeter. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device will be conducted. Calibration and frequency of calibration is according to manufacturer's specifications.
Purpose of data	The values applied ex ante for this parameter have been considered to be in dry basis so values in wet basis have not been used in the calculation.
Additional comment	This parameter will be monitored in Options B 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 since flowmeters that automatically express LFG volumes in normalized cubic meters will be used.

Data / Parameter	$F_{CH4,EG,t}$
Unit	kg
Description	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t
Source of data	Measurements undertaken by a third party accredited entity
Value(s) applied	For the determination ex ante, the $F_{CH4,EG,t}$ has not been used since the flare efficiency has been determined exante as 90%. For the determination ex post in the project activity, measured flare efficiency will be used to calculate the amount of methane destroyed by flaring ex post as per Option B.1 of "Project emissions from flaring" version 02.0.0. Under Option B.1, the measurement is conducted by an accredited entity on a biannual basis.
Measurement methods and procedures	Measure the mass flow of methane in the exhaust gas according to an appropriate national or international standard e.g. UKs Technical Guidance LFTGN05. The time period t over which the mass flow is measured must be at least one hour. The average flow rate to the flare during the time period t must be greater than the average flow rate observed for the previous six months
Monitoring frequency	Biannual
QA/QC procedures	According to the standard applied.
Purpose of data	Calculation of project emissions
Additional comment	Monitoring of this parameter is required because the project activity uses the case of enclosed flares and selects Option B.1 to determine flare efficiency

Data / Parameter	$Maintenance_y$
Unit	Calendar dates
Description	Maintenance events completed in year y
Source of data	Project participants
Value(s) applied	Not used in the calculations ex-ante.
Measurement methods and procedures	Record the date that maintenance events were completed in year y. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates
Monitoring frequency	Annual
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of the flare
Purpose of data	Calculation of project emissions
Additional comment	Monitoring of this parameter is required for the case of enclosed flares and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer (SPEC,flare)

Data / Parameter	**T_t**
Unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measured by a flow meter
Value(s) applied	For ex-ante determination, gaseous stream flow temperature being below 60ºC is adopted.
Measurement methods and procedures	Continuous measurement. Data will be recorded electronically, and will be kept during the crediting period and two years after. The measurement method will be based in the thermal principle of the thermal mass flowmeter, which can also measure the temperature of the gaseous stream. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Data will also be aggregated monthly/yearly
QA/QC procedures	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
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. The applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted and therefore, this parameter must be monitored continuously to assure the applicability condition is met.

Data / Parameter	**P_t**
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	Measured by a pressure meter
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	Continuous measurement. Data will be recorded electronically, and will be kept during the crediting period and two years after. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Data will also be aggregated monthly/yearly
QA/QC procedures	Pressure meters should be subject to a regular maintenance and testing regime to ensure accuracy
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. The applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted and therefore, this parameter must be monitored continuously to calculate saturation absolute humidity ($m_{H2O,t,db,sat}$)

Data / Parameter	$v_{CH4,t,db}$
Unit	m^3 CH4/m^3 dry gas
Description	Volumetric fraction of CH4 in a time interval t on a dry basis
Source of data	Measured continuously by the project participant using certified equipment
Value(s) applied	50%
Measurement methods and procedures	Continuous gas analyser operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature. The measurement method will be based in the NDIR (Non Dispersed Infrared) method of the continuous gas analyzer. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 2% full scale. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
Monitoring frequency	Continuous
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N2) 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 in Options A and B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", version 2.0.0. Its calibration frequency would be as per manufacturer instructions. The meter has been installed in this first phase of the project activity in the main line between the flare and the booster.

Data / Parameter	**$EL_{LFG,y}$**
Unit	MWh
Description	Net quantity of electricity generated using LFG
Source of data	Measured by electricity meter
Value(s) applied	<table><tr><th>Year Period</th><th>$EL_{LFG,y}$</th></tr><tr><td>8</td><td>38,400</td></tr><tr><td>9</td><td>38,400</td></tr><tr><td>10</td><td>38,400</td></tr><tr><td>11</td><td>38,400</td></tr><tr><td>12</td><td>38,400</td></tr><tr><td>13</td><td>38,400</td></tr><tr><td>14</td><td>38,400</td></tr></table>
Measurement methods and procedures	Electricity meter will be used to measure $EL_{LFG,y}$. The measurement method will be based in the principle that the electricity reading is the power accumulated over a period divided by the duration of such period. The readings will be gathered automatically by an electricity meter and the project participant will be receiving the corresponding bills, which will be used as the monitoring data source.. The accuracy of the measurement equipment will be 1% of maximum reading. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the electricity company.
Monitoring frequency	It will be calculated from continuous measurement 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 meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy.
Purpose of data	Calculation of baseline emissions
Additional comment	Required to estimate the emission reductions from electricity generation from LFG.

Data / Parameter	**$EG_{EC,y}$**
Unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Source of data	Measured by electricity meter
Value(s) applied	The value has been considered as 0 ex ante.
Measurement methods and procedures	Electricity meter will be used to measure $EG_{EC,y}$. The measurement method will be based in the principle that the electricity reading is the power accumulated over a period divided by the duration of such period. The readings will be gathered automatically by an electricity meter and the project participant will be receiving the corresponding bills, which will be used as the monitoring data source.. The accuracy of the measurement equipment will be 1% of maximum reading. The responsible person/entity for the measurement will be the project participant. The calibration will be carried out yearly or at the frequency required by the electricity company.
Monitoring frequency	It will be calculated from continuous measurement 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 meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy.
Purpose of data	Calculation of project emissions
Additional comment	Required to estimate the emission reductions from electricity generation from LFG.

Data / Parameter	**$Op_{engine,h}$**
Unit	-
Description	Operation of the engine that consumes the LFG
Source of data	The project participant uses an exante operational time of 8,000 h/year as a conservative assumption considering that the equipment will require maintenance works. The maintenance works would lead to downtimes equating to approximately 760 h/year.
Value(s) applied	For exante determination, $Op_{engine,h}$ has been considered to be 1 for 8,000 h/year.
Measurement methods and procedures	For the engine using the LFG, the plant is operating in hour h by monitoring the product generated by the engine (i.e Net quantity of electricity generated using LFG). The method to determine the operation of the engine that consumes the LFG would be: • $Op_{engine,h}$=0 when no net quantity of electricity is generated using LFG in the hour h. • $Op_{engine,h}$=1 when net quantity of electricity is generated using LFG in the hour h.
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	The project participant uses an exante operational time of 8,000 h/year as a conservative assumption considering that the equipment will require maintenance works. The maintenance works would lead to downtimes equating to approximately 760 h/year.
Value(s) applied	For exante determination, $Op_{flare,h}$ has been considered to be 1 for 8,000 h/year.
Measurement methods and procedures	For the enclosed flare using the LFG, the plant is operating in hour h by monitoring, at least, the flame detection system. The flame detection system is used to ensure that the equipment is in operation since the control system of the equipment ensures that the enclosed flare will stop if no flame is detected. The method to determine the operation of the enclosed flare using the LFG would be: • $Op_{flare,h}$ =0 when flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); • $Op_{flaree,h}$=1 when flame is detected continuously in hour h (instantaneous measurements are made at least every minute).
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	The project participant uses an exante operational time of 8,000 h/year as a conservative assumption considering that the equipment will require maintenance works. The maintenance works would lead to downtimes equating to approximately 760 h/year.
Value(s) applied	For exante determination, $Flame_m$ has been considered to be on for 8,000 h/year.
Measurement methods and procedures	Measured using a Ultra Violet detector or Infra-Red or both. The flame detection system is used to ensure that the equipment is in operation since the control system of the equipment ensures that the enclosed flare will stop if no flame is detected. The method to determine wether the flame is on or off would be: • Flame off: when flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); • Flame on: when flame is detected continuously in hour h (instantaneous measurements are made at least every minute).
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	$PE_{EC,y}$
Unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year *y*
Source of data	Calculated as per the “Tool to calculate baseline, project and or leakage emissions from electricity consumption”.
Value(s) applied	see table below
Measurement methods and procedures	The calculation procedures and methods will be defined according to the case presented during the crediting period for the project activity, according to one of the following possible scenarios: a) Electricity consumption from the grid; or b) Electricity consumption from (an) off-grid captive power plant(s); or c) Electricity consumption from the grid and (a) captive power plant(s).
Monitoring frequency	It will be measured at continuously.
QA/QC procedures	As per the latest version of the “Tool to calculate baseline, project and or leakage emissions from electricity consumption”.
Purpose of data	Calculation of project emissions
Additional comment	For ex-ante purposes, it was followed case a) in order to estimate project emissions from electricity consumption from the grid.

Value(s) applied:

Year Period	$PE_{EC,y}$
8	268
9	268
10	268
11	268
12	268
13	268
14	268

<table>
<tr><td>Data / Parameter</td><td>$FC_{i,j,y}$</td></tr>
<tr><td>Unit</td><td>Mass or volume unit per year (e.g. ton/yr or m3/yr)</td></tr>
<tr><td>Description</td><td>Quantity of fuel type i combusted in process j during the year yy</td></tr>
<tr><td>Source of data</td><td>Onsite measurements</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Year Period</th><th>$FC_{i,j,y}$</th></tr>
<tr><td>8</td><td>0</td></tr>
<tr><td>9</td><td>0</td></tr>
<tr><td>10</td><td>0</td></tr>
<tr><td>11</td><td>0</td></tr>
<tr><td>12</td><td>0</td></tr>
<tr><td>13</td><td>0</td></tr>
<tr><td>14</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Measurement methods and procedures</td><td>

Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift);
Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance;
In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions.

</td></tr>
<tr><td>Monitoring frequency</td><td>It will be measured at continuously.</td></tr>
<tr><td>QA/QC procedures</td><td>The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes.
Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>For ex-ante purposes, since the fuel will be used mainly for the diesel backup generator, the value applied for the parameter is 0 because the consumption of fossil fuel is not considered as the normal operational conditions of the project activity.</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$NCV_{i,y}$</td></tr>
<tr><td>Unit</td><td>GJ/m3</td></tr>
<tr><td>Description</td><td>Weighted average net calorific value of fuel type i in year y</td></tr>
<tr><td>Source of data</td><td>In line with the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" Version 02, he following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>a) will be available.</td></tr>
<tr><td>b) Measurements by the project participants</td><td>b) will not be applied, because a) will be available</td></tr>
<tr><td>c) Regional or national default values</td><td>c) will not be applied, because a) will be available</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available, IPCC default values will be used according to left column.</td></tr>
</table></td></tr>
<tr><td>Value(s) applied</td><td>For ex-ante purposes, since the fuel will be used mainly for the diesel backup generator, no value has been used for the parameter because the consumption of fossil fuel is not considered as the normal operational conditions of the project activity.</td></tr>
<tr><td>Measurement methods and procedures</td><td>For a) Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency</td><td>For a) : The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account</td></tr>
<tr><td>QA/QC procedures</td><td>Verify if the values under a) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a) should have ISO17025 accreditation or justify that they can comply with similar quality standards.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>Applicable where Option B is used</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>$EF_{CO2,i,y}$</td></tr>
<tr><td>Unit</td><td>tCO2/GJ</td></tr>
<tr><td>Description</td><td>Weighted average CO2 emission factor of fuel type i in year y</td></tr>
<tr><td>Source of data</td><td>In line with the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” Version 02, he following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>a) will be available.</td></tr>
<tr><td>b) Measurements by the project participants</td><td>b) will not be applied, because a) will be available</td></tr>
<tr><td>c) Regional or national default values</td><td>c) will not be applied, because a) will be available</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available, IPCC default values will be used according to left column.</td></tr>
</table></td></tr>
<tr><td>Value(s) applied</td><td>For ex-ante purposes, since the fuel will be used mainly for the diesel backup generator, no value has been used for the parameter because the consumption of fossil fuel is not considered as the normal operational conditions of the project activity.</td></tr>
<tr><td>Measurement methods and procedures</td><td>For a) Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency</td><td>For a) : The $EF_{CO2,i,y}$ should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account</td></tr>
<tr><td>QA/QC procedures</td><td>Applicable where option B is used.
For a): If the fuel supplier does provide the NCV value and the CO2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO2 factor should be used. If another source for the CO2 emission factor is used or no CO2 emission factor is provided, Option d) should be used.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>Applicable where Option B is used</td></tr>
</table>

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 although there might be several monitoring ports to measure the different temperatures along the flare stack.. The measurement method will be based in the thermoelectric principle of the thermocouple. The readings will be gathered automatically by an automatic data collection system. The accuracy of the measurement equipment will be 1.1ºC. The responsible person/entity for the measurement will be the project participant. The calibration or replacement will be carried out yearly or at the frequency required by the manufacturer following the recommended procedures.
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	Not used in the calculations
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.

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 on normal operation conditions, 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 to be described in the CDM-PDD.

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. In case of automatic data collection fails, a manual collection system will be used applying the conservative error required.

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. A daily visual inspection is carried out by a designated / trained landfill employee. During this daily 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.

The following table summarizes the roles and responsibilities of project sponsor with regard to the monitoring system for the project:

Task	Roles and responsibilities
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 • Implement sign-off system for records and completed worksheets

Task	Roles and responsibilities
Performance monitoring and reporting	• Analyze data and compare project performance with project targets • Analyze system problems and implement improvements (performance management) • Prepare annual report and worksheets
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
- 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. In case of automatic data collection fails, a manual collection system will be used applying the conservative error required.

If the flare is not operational, landfill gas will not be combusted and therefore no credits will be claimed during this period. The running hours of the flares will be monitored as part of the monitoring procedures.

SECTION C. Duration and crediting period

C.1. Duration of project activity
C.1.1. Start date of project activity
>>
05/03/2007

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 05/03/2014 to 04/03/2021 (both days included).

C.2.3. Length of crediting period
>>
Seven years.

SECTION D. Environmental impacts

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 D on environmental impacts remains to be the same as that for the registered CDM-PDD corresponding to the first crediting period.

D.1. Analysis of environmental impacts

>>

The potential environmental impacts[31] and how the sponsor will mitigate those impacts are listed below:

Construction Phase:

- Machinery translation: The noise generated by the machinery movement in the construction phase, eventually could be perturbing. To avoid it, mufflers should be installed in the vehicles that transport the equipment. Mufflers should be required to all vehicles that enter the project site. Moreover, it will be prohibited that vehicles' motors are turned on for unnecessary long periods of time both out and inside the landfill territory. The transportation of the equipment for the project construction should be done in the schedule that is most convenient in order to avoid disturbing the population who live nearby.

- Drilling for the LFG capture: It should be assured that the employees involved count with personal protection equipment, which is worn correctly. Vehicles' motors should be turned off and be far away from the drilling wells, during the drilling. It should be assured the optimal operational condition of the machinery that will do the drilling, before proceeding to do the drilling. The personnel that will perform the drilling should be prepared to verify the machinery conditions.

- Installation of the LFG capture-equipment: A previous check of the optimal operational conditions of the equipment, adequately programming of the drilling works, sealing of the wells immediately after the drilling, should be performed. With regards to bad odors, the personnel in charge of this activity should count necessarily with masks to avoid them.

Operations Phase:

- Condensation of liquids: A preventive maintenance and periodic controls of the state of the mechanical equipment involved in the transportation and storage of the liquids after their condensation should be enforced. Continuous supervision of the infrastructure built for the liquids transportation should be performed. The liquids should be discharged periodically into the wells.

- LFG utilization equipment: Disturbing noises should be minimized/avoided. Audition blockage devices should be provided to employees in case the noise exceeds the limit imposed by local regulations. All machinery involved should keep optimal operational conditions.

- Noise: To mitigate the impact of noises against health and security during operation, machinery maintenance should be performed. Moreover, the plant personnel should use audition protection, in case noises go over the limit imposed by local regulation.

[31] As per the recommendations set in the project's Environmental Impact Assessment (EIA) available to the DOE upon request. An EIA is not a legal requirement for the project, however an EIA was completed in May 2005.

- Condensate liquids: A preventive maintenance and functions control of all the installations used by condensate liquids (this includes the valves, tubes, tramps, capturing wells) should be performed to avoid a negative impact in the ground and underground level of LFG recovery plant. With regards to health and security of the personnel, they should wear all the recommended clothes and gadgets (overall, plastics boots, gloves, masks, etc.).

- Personnel's health risk: To mitigate the impacts that the plant operations could generate in the health and security of workers, training to the personnel should be performed regarding all their functions/roles in the project.

- Accidents and contamination risks: To mitigate impacts that the project can originate to the workers' security and health, training should be done for the personnel regarding how to proceed under accidents occurrences or in case of an eventual intoxication for the inhalation of the LFG or accidental swallow of the condensate liquids. Additionally, a supervision of the personnel' clothes and wearing devices should be performed.

Closure of the landfill phase:

- De-installation of the infrastructure and machinery: The impacts in this phase are similar to the ones identified in the construction phase; in consequence, the mitigation of environmental risks in this phase is similarly achieved. One of the risks to take into account is the temporary bad-odor created during the de-installation of the equipment; this should be prevented by the personnel through the use of masks.

D.2. Environmental impact assessment

>>

The Environmental Impact Assessment (EIA) is available to the DOE upon request. An EIA is not a legal requirement for the project, however an EIA was completed in May 2005 at the sponsor own initiative. In the EIA, the environmental impacts of the project activity were not considered significant.

SECTION E. Local stakeholder consultation

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 (CDM-PDD) relating to the *baseline*, *estimated emission reductions* and the *monitoring plan* using an approved baseline and monitoring methodology"; therefore section E on local stakeholder consultation remains to be the same as that for the registered CDM-PDD corresponding to the first crediting period.

E.1. Solicitation of comments from local stakeholders

>>

The public consultation was developed by a governmental organization, named FONAM, Environmental National Fund, not by the Sponsor, preventing any bias. The Public Consultation is a requirement of the DNA. The main criteria for selection of the 11 organizations interviewed were two:

- -A large number of habitants are members to them or can be gathered at them.
- -Closeness to the project – at least one organization was chosen representing districts that fall into the project indirect area of influence. Note that the project is 5 Km away from any population, as required by law for this type of activity. The population that lives in the project's area of influence is composed by three major associations named La Florida, Saracoto Alto and Sol de Cajamarquilla[32] and new associations i.e. La Campiña, Las Magnolias, Santa Cruz, Usufrutuarios, Residencial Cajamarquilla, Los Aviadores. Complete Public Consultation document is made available to the DOE.

The public consultation was performed in III stages:

I. **Identification of local stakeholders:** 11 social organizations were identified. These were 1) Vivienda La Florida, 2) Saracoto Pig-Farmers Association, 3) Vivienda del Sol de Cajamarquilla Association, 4) Las Tunas Municipality, 5) School #1275, 6) APAFA #1275, 7) School # 201, 8) APAFA#201, 9) Julio C. Tello Association, 10) Cajamarquilla Residents Association, 11) Santa Rosa de Jicamarca Association).

II. **Identification of subjects of interest:** 7 Informative visits were performed and 2 general informative gatherings were announced. Visited places were 1) Popular Dinner Center Santa Rosa de Jicamarca (8 habitants were present), 2) Popular Dinner Center Saracoto Alto (7 habitants were present), 3) Julio C. Tello Association (17 habitants were present), 4) School#1275 (7 school-teachers were present), 5) School #201 (5 professors were present), 6) Cajamarquilla Residents Association (12 habitants were present) , 7) Saracoto Alto Pig-Farmers Association (9 habitants were present). Interviews were held in each visit. 2 General Informative Gathering were held on April 13th and April 16th, 2005; all visited local groups were invited to attend this event and to present their subjects of interests regarding the project publicly (37 persons assisted the first meeting and 45 the second meeting, local authorities representing their associations attended).

III. **Community Development Plan:** The sponsor committed with the community to invest in the major subjects of interest identified.

E.2. Summary of comments received

>>

The project activity was positively accepted by the public; basically only two claims/negative comments were received:

[32] The population of these 3 associations is 850 habitants.

- -The landfill could contaminate the food that pigs are fed in the pig farms that are nearby the project site.
- -The project CDM revenues should be shared with the local population, i.e. in building a health center, reforesting parks and entering zones, improving the project-site driving road, providing light up to 2 Kms. away from the project site entering zone, building a bridge, supporting local NGO (CEPRODEP) hiring young local people.

E.3. Report on consideration of comments received

>>

The sponsor has committed to a social agenda ("Community Development Plan") that more than satisfies the demands described in E.2, which require due account. The Community Development Plan ("CDP") includes the following:

1) Provide to Florida, Saracoto Alto and Sol de Cajamarquilla water tanks of 3,000 gallons capacity, and fill them with water every other day.
2) Finance studies for water and sanitary watering drainage system projects in Florida, Saracoto Alto and Sol de Cajamarquilla.
3) Support the improvement of the 2 kilometer-driving road in *Quebrada Huaycoloro*.
4) Support the study of a pigs-feeding-and-commercialization project.
5) Reforesting parks and entering zones, in coordination with the community and the local major's office.
6) Review the proposal of Mr. Javier Farfán to complete the works that the NGO CEPRODEP has been developing in mechanics-services, computer-services and automobile-services.
7) Review the hiring of young people who live in the surroundings according to qualifications.
8) Cleaning of the Huaycoloro River in coordination with the community and the local major's office.

The project acceptance spectrum can be seen in the following chart.

Acknowledgement of the Huaycoloro CDM project[33]

Main subjects	Local Authorities	Community
Historical Agreements.	x	x
CDM and Environmental Practices Knowledge	x	x
Support to Social Programs[34]	x	x
Annoyance[35]		x
Reliability of the project[36]	x	x
Local labor creation capacity[37]		x
Common shared benefits[38]	x	x

[33] The Public Stakeholders Comment Report prepared by FONAM.
[34] Referred to the provision of water through water tanks in trucks, financing of water and water-drainage studies, pig-farm studies, repairing of a 2km-driving road and reforestation programs.
[35] Referred to pig-farms problems
[36] Existence of positive expectancy regarding the project, expressed on April 16h, 2005.
[37] Expectancy of local labor hiring.
[38] Sharing of the project benefits with local community, expressed on April 16th, 2005.

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.

- - - - -

Appendix 1: Contact information of project participants

Organization name	Petramas
Street/P.O. Box	Av Tomas Marsano 2813- piso 8
Building	-
City	Lima
State/Region	Lima/Santiago de Surco
Postcode	Lima 41
Country	Peru
Telephone	
Fax	
E-mail	
Website	
Contact person	
Title	
Salutation	Mr.
Last name	Zegarra
Middle name	
First name	Jorge
Department	
Mobile	
Direct fax	
Direct tel.	Petramas
Personal e-mail	jzegarra@petramas.com

Organization name	International Bank for Reconstruction and Development (IBRD) as Trustee of the Netherlands CDM Facility (NCDMF).
Street/P.O. Box	
Building	1818H Street
City	Washington DC
State/Region	Washington DC
Postcode	20433
Country	Unites States of America
Telephone	
Fax	
E-mail	IBRD-carbonfinance@worldbank.org
Website	
Contact person	
Title	Carbon Fund Manager
Salutation	Ms.
Last name	Chassard
Middle name	
First name	Joelle
Department	World Bank Carbon Finance Business Unit
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Organization name	ICECAP Carbon Portfolio Limited
Street/P.O. Box	5-8 The Sanctuary
Building	
City	London
State/Region	
Postcode	SWIP 3JS
Country	United Kingdom of Great Britain and Northern Ireland
Telephone	+44 020 7340 0919
Fax	+44 020 7222 3139
E-mail	greg@icecapltd.com
Website	www.icecapltd.com
Contact person	Gregory Dunne
Title	Senior Engineer
Salutation	
Last name	Dunne
Middle name	
First name	Gregory
Department	The Diversity Office
Mobile	+44 138 8506 5709
Direct fax	+44 020 7222 3139
Direct tel.	+44 020 7340 0919
Personal e-mail	greg@icecapltd.com

Organization name	Statkraft Markets GmbH
Street/P.O. Box	Derendorfer Allee 2a
Building	
City	Düsseldorf
State/Region	
Postcode	DE-40476
Country	Germany
Telephone	+49 211 60 244 000
Fax	+49 211 60 244 199
E-mail	CO2@Statkraft.com
Website	
Contact person	Stef Peters
Title	Managing Director
Salutation	
Last name	Peters
Middle name	
First name	Stef
Department	
Mobile	
Direct fax	+31 207 95 7899
Direct tel.	+31 207 95 7800
Personal e-mail	Stef.Peters@statkraft.com

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 selected methodology

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 17 Baseline determination information

Data	Value	Unit	Source
Year of opening	1994	Year	Landfill information
Year of closure	2029	Year	Landfill information
Waste composition Wood and wood products Pulp, paper and cardboard Food waste Textiles Garden waste Inert waste	 3% 17% 36% 4% 12% 29%	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	 0.03 0.06 0.185 0.06 0.1 0	-	IPCC 2006 For tropical wet climate
DOCf	0.5		IPCC 2006
DOCj Wood and wood products Pulp, paper and cardboard Food waste Textiles Garden, Yard and Park Waste Inert waste	 43 40 15 24 20 0	%	IPCC 2006 Wet Waste

Table 18. Domestic waste to be deposited annually.

Waste deposition data	
Year	**Domestic waste load (tons)**
1994	182,498
1995	255,004
1996	292,014
1997	398,495
1998	438,221
1999	547,503
2000	643,987
2001	608,242
2002	707,685
2003	718,300
2004	729,100
2005	740,000
2006	751,100
2007	762,400
2008	773,800
2009	785,400
2010	797,200
2011	809,200
2012	821,300
2013	833,600
2014	846,100
2015	858,800
2016	871,700
2017	884,800
2018	898,100
2019	911,600
2020	925,300
2021	939,200
2022	953,300
2023	967,600
2024	982,100
2025	996,800
2026	1,011,800
2027	1,027,000
2028	1,042,400
2029	1,058,000
2030	1,073,900
2031	1,090,000
2032	1,106,400
2033	1,123,000
2034	1,139,800
2035	1,156,900
2036	1,174,300
2037	1,191,900
2038	1,209,800
2039	1,227,900
2040	736,451

Table 19 Mean annual meteorological values for the site temperature and rainfall[39]

Month	Mean temperature (Celsius)	Mean precipitation (mm)
Jan	22.5	0.9
Feb	23.0	0.3
Mar	22.6	4.9
Apr	21.0	0.0
May	18.9	0.1
Jun	17.5	0.3
Jul	16.9	0.3
Aug	16.5	0.3
Sep	16.7	5.4
Oct	17.6	0.2
Nov	19.2	0.0
Dec	20.8	0.3
Mean annual	**19.40**	**13**

[39] http://www.worldweather.org/029/c00108.htm

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

The GHG emission calculation of the proposed project was based on the instruction of "Tool to Calculate the Emission Factor for an Electricity System" (Version 4.0).

Determination of Grid Emission Factor

The "Tool to Calculate the Emission Factor for an Electricity System" (Version 4.0) is applied to calculate the combined margin emission factor. This section describes how the emission factor of the proposed project activity has been determined based on the instructions for calculating the emission factors of the operating margin (OM) and build margin (BM).

According to the tool the grid emission factor is calculated as per the following six steps:

STEP 1: Identify the relevant electricity systems.
STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional).
STEP 3: Select a method to determine the operating margin (OM).
STEP 4: Calculate the operating margin emission factor according to the selected method.
STEP 5: Calculate the build margin (BM) emission factor.
STEP 6: Calculate the combined margin (CM) emissions factor.

Step 1 - Identify the relevant electricity systems

Electricity generated by the proposed project activity will displace the power production in the national grid of Peru (SEIN) which is defined as the project electricity system by default.

For the purpose of determining the operating margin emission factor, the CO2 emission factor(s) for net electricity imports from a connected electricity system is 0 tCO2/MWh, because information is not available for emission factors of any of the neighboring countries.

Step 2 - Choose whether to include off-grid power plants in the project electricity system

The calculation of the operating margin and build margin emission factor will use the **option I** of the tool: *Only grid power plants are included in the calculation*. Off-grid power plants are not included in the calculations as information is not available.

Step 3 - Select a method to determine the operating margin (OM)
The "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0", provides the following four options to determine the operating margin:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.

The methodology tool states that the Simple Operating Margin method can only be used where low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.

In the case of the project activity, out of the four options for the OM, the option (b) Simple adjusted OM was selected. The ex-ante option has been chosen which means that the weighted calculation over the last 3 years (most recent years with available data are 2010, 2011 and 2012) has been applied.

The Simple OM method cannot be used since low cost, must-run resources constitute more than 50% of total grid generation in Peru. The following table lists the average electricity generated in the five most recent years and shows that the Simple OM method is not applicable to the grid in Peru, given that power generation from low-cost/must-run sources is greater than 50% (equivalent to 57%):

Year	Low-cost/must-rungeneration (MWh)	Generation excluding Low-cost/must-run source (GWh)	Total Generation	Low-cost/must-run generation (%)	
2008	11,548,480	11,548,480	23,096,960	50%	>50%
2009	18,751,670	11,055,580	29,807,250	63%	>50%
2010	18,964,560	13,462,270	32,426,830	58%	>50%
2011	20,404,100	14,813,300	35,217,400	58%	>50%
2012	20,908,300	16,412,900	37,321,200	56%	>50%
Power generation from low-cost/must-run sources				**57%**	**>50%**

Also, it was not necessary to use either the Dispatch data analysis OM approach or the Average OM approach because detailed dispatch data is unaffordable to process due to economical reasons for the renewal of the CDM-PDD.

According to the Tool, when the simple Adjusted OM method is applied, the power generating units in the system are divided into two categories these are: low-cost/must-run sources and the no low-cost/must run sources. For the SEIN, the low-cost/ must-run sources include the plants powered by renewable energy such as hydropower, and turbo steam plants using waste biomass. On the other hand, the no low-cost/must-run sources are represented by thermal generation plants connected to the SEIN, which are powered by fossil fuels.

Step 4 - Calculate the operating margin emission factor according to the selected method

The simple adjusted OM emission factor ($EF_{grid,OM\text{-}adj,y}$) is a variation of the simple OM, where the power plants/units (including imports) are separated in low-cost/must-run power sources (k) and other power sources (m). As under Option A of the simple OM, it is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

The emission factor is calculated as follows:

$$EF_{grid,OM-adj,y} = \left(1-\lambda_y\right) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}}$$

Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"

Where:

$EF_{grid,OM\text{-}adj,y}$ = Simple adjusted operating margin CO2 emission factor in year y (t CO2/MWh)

λ_y = Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y

$EG_{m,y}$= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

$EG_{k,y}$= Net quantity of electricity generated and delivered to the grid by power unit k in year y (MWh)

$EF_{EL,m,y}$= CO2 emission factor of power unit m in year y (t CO2/MWh)

$EF_{EL,k,y}$=	CO2 emission factor of power unit k in year y (t CO2/MWh)
m=	All grid power units serving the grid in year y except low-cost/must-run power units
k=	All low-cost/must run grid power units serving the grid in year y
y=	The relevant year as per the data vintage chosen in Step 3

$EF_{EL,m,y}$, $EF_{EL,k,y}$, $EG_{m,y}$ and $EG_{k,y}$ should be determined using the same procedures as those for the parameters $EF_{EL,m,y}$ and $EG_{m,y}$ in Option A of the simple OM as follows:

- **$EF_{EL,m,y}$, $EF_{EL,k,y}$:** The CO2 emission factor of the grid power units n ($EF_{EL,m,y}$) should be determined as per the guidance for the simple OM, using the Options A1, A2 or A3. The Project activity will determine $EF_{EL,n,y}$ using Option A1 for the simple OM (where $EF_{EL,n,y}$ is stated as $EF_{EL,m,y}$). Under such option, if for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

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

Equation 2 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"

Where:

$EF_{EL,m,y}$ =	CO2 emission factor of power unit m in year y (t CO2/MWh)
$FC_{i,m,y}$=	Amount of fuel type i consumed by power unit m in year y (Mass or volume unit)
$NCV_{i,y}$=	Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,}$y=	CO2 emission factor of fuel type i in year y (t CO2/GJ)
$EG_{m,y}$=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
m=	All power units serving the grid in year y except low-cost/must-run power u nits
i=	All fuel types combusted in power unit m in year y
y=	The relevant year as per the data vintage chosen in Step 3

- **EGm,y** and **EGk,y:** The net quantity of electricity generated and delivered to the grid by power unit has been determined as per the guidance for the simple Adjusted OM method using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option). Off-grid power plants or net electricity imports are not included in the operating margin emission factor

In equation 8 above, the parameter λ_y is defined as follows:

$$\lambda_y(\%) = \frac{Number\ of\ hours\ \text{low} - \text{cost/must} - \text{run}\ are\ on\ the\ margin\ in\ year\ y}{8760\ hours\ per\ year}$$

Equation 9 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"

Lambda (λ_y) should be calculated as follows:

- Step (i) - Plot a load duration curve. Collect chronological load data (typically in MW) for each hour of the year y, and sort the load data from the highest to the lowest MW level. Plot MW against 8760 hours in the year, in descending order;
- Step (ii) - Collect electricity generation data from each power plant/unit. Calculate the total annual generation (in MWh) from low-cost/must-run power plants/units (i.e. Σk EGk,y);
- Step (iii) - Fill the load duration curve. Plot a horizontal line across the load duration curve such that the area under horizontal line and the curve right from the intersection point (MW times hours) equals the total generation (in MWh) from low-cost/must-run power plants/units (i.e. Σ k EGk,y);
- Step (iv) - Determine the "Number of hours for which low-cost/must-run sources are on the margin in year y. First, locate the intersection of the horizontal line plotted in Step (iii) and the load duration curve plotted in Step (i). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and λ_y is equal to zero.

In determining λ_y only grid power units (and no off-grid power plants) should be considered.

The above procedure has been followed for the calculation of λ_{2012} and λ_{2011} (there is no data available in the COES to conduct the calculation of λ_{2010}). The result shown in the Excel file "Calculation Lambda_2011-2012" concludes that the lines for λ_{2012} and λ_{2011} do not intersect, therefore the low-cost/must-run sources do not appear on the margin and λ_{2012} and λ_{2011} are equal to zero.

The following two figures show the calculation of λ_{2012} and λ_{2011}:

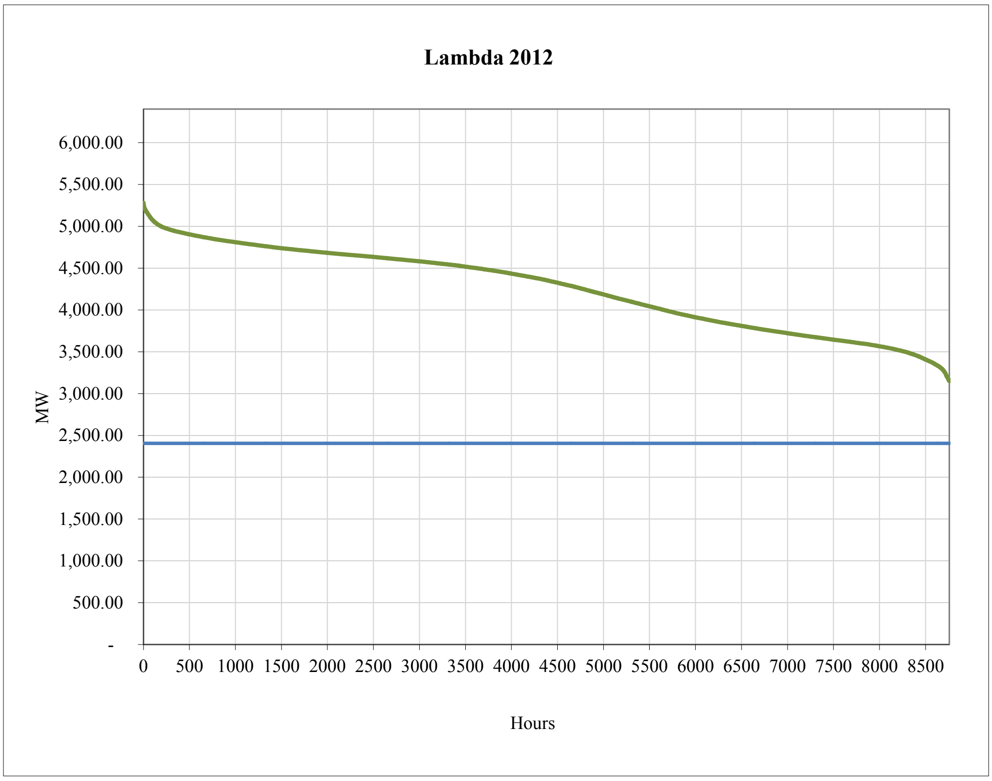

Figure 4. Calculation of λ_{2012} concluding that the lines do not intersect and therefore, $\lambda_{2012}=0$

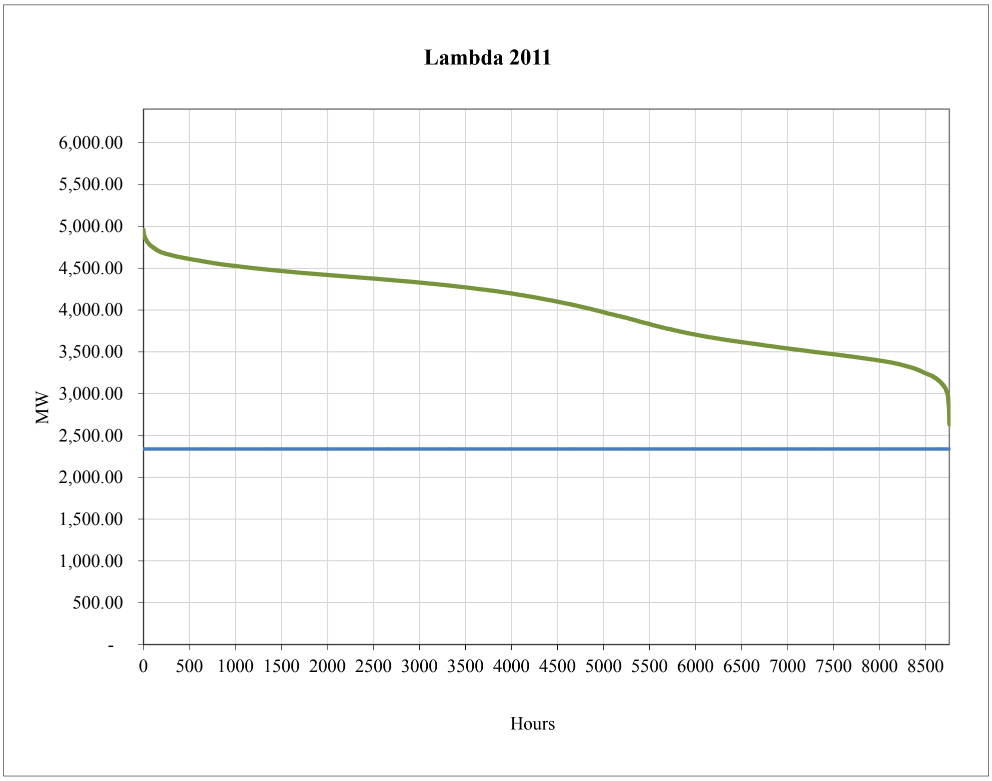

Figure 5. Calculation of λ_{2012} concluding that the lines do not intersect and therefore, λ_{2011}=0

From the results of λ_{2012} and λ_{2011} and the fact that there is no data available in the COES to conduct the calculation of λ_{2010}, it has been extrapolated that λ_{2010}=0.

Consiering the results of $\lambda_{2012} = \lambda_{2011} = \lambda_{2010}=0$, the Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0" can be simplified to consider only the grid power units serving the grid in year y except low-cost/must-run power units:

$$EF_{grid,OM-adj,y} = \left(1-\lambda_y\right) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Simplification of Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"

Where:

$EF_{grid,OM-adj,y}$ =	Simple adjusted operating margin CO2 emission factor in year y (t CO2/MWh)
λ_y =	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year y
$EG_{m,y}$=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$=	CO2 emission factor of power unit m in year y (t CO2/MWh)
m=	All grid power units serving the grid in year y except low-cost/must-run power units
y=	The relevant year as per the data vintage chosen in Step 3

Applying the above formulas for each of the vintage years, the following table can be summarized:

Parameter	$EF_{grid,OM-adj,\ 2012}$	$EF_{grid,OM-adj,\ 2011}$	$EF_{grid,OM-adj,\ 2010}$	Units
Value	0.55048	0.57679	0.59910	t CO2/MWh
Parameter	EG_{2012}	EG_{2011}	EG_{2010}	**Units**
Value	16,250,050	14,726,002	13,384,060	MWh
$EF_{grid,OM-adj,\ 2010-2012} = (EF_{grid,OM-adj,\ 2012} * EG_{2012} + EF_{grid,OM-adj,\ 2011} * EG_{2011} + EF_{grid,OM-adj,\ 2010} * EG_{2010}) / (EG_{2012} + EG_{2011} + EG_{2010})$				
$EF_{grid,OM-adj,\ 2010-2012}$	Calculated as weighted average		**0.57388**	t CO2/MWh

As per the above table, the Operating Margin Emission Factor ($EF_{grid,OM-adj,\ 2010-2012}$) has been calculated using a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation (2010 to 2012) as required by the "Tool to calculate the emission factor for an electricity system" version 04.0 paragraph 36(a) and results in **0.57388 tCO2/MWh**[40]**.**

The following tables show the data used to calculate the the Operating Margin Emission Factor ($EF_{grid,OM-adj,y}$) for 2012, 2011 and 2010:

[40] See detailed calculation in Excel Spreadsheet “EF_Peru_2012” provided to DOE

Sources	**Document**	COES_Estadística de Operaciones_2012	COES_Estadística de Operaciones_2012	COES_Estadística de Operaciones_2012	N/A	IPCC 2006 Vol 2	"The Energy and Fuel Data Sheet" Iain Staffell, University of Birmingham, UK	IPCC 2006 Vol 2	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Appendix 1 of the "Tool to calculate the emission factor for an electricity system" version 4.0	COES_Estadística de Operaciones_2012	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Webpage	http://www.coes.org.pe/wcoes/coes/salapr ensa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salapre nsa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salapre nsa/estadistica_anual.aspx	Calculated to convert from ft3 or gal to m3	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	http://www.claverton-energy.com/wp-content/uploads/2012/08/the_energy_and_fuel_data_sheet.pdf	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	Calculated as per Equation 2 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Default	http://www.coes.org.pe/wcoes/coes/salapr ensa/estadistica_anual.aspx	Calculated as per Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Table (page)	Table N° 6.2 (68)	Table N° 6.2 (68)	Table N° 6.2 (68)	N/A	Table 1.2 (1.19)	Page 2	Table 1.4 (1.25)	Calculated	Appendix 1 (33)	Table N° 6.2 (68)	Calculated
2012	**Power Plant**	**EG_{2012} [MWh]**	**Fuel Type**	**FCi Natural Gas [1000ft3] Diesel [gal] Coal [ton]**	**FCi [m^3]**	**NCVi [GJ/ton]**	**Density [ton/m³]**	**EF_{CO2} [tCO2/GJ]**	**$EF_{EL,m,y}$ [t CO2/MWh]**	**$\eta_{m,y}$ (%)**	**EGm,y (MWh)**	**$EF_{EL,m,y} * EG_{m,y}$**
	TG Santa Rosa WTG - D2	15,640.039	Diesel	1,403,848	6,382.03	43.00	0.837	0.0741	1.0883	39.00%	15,640	17,020
	TG Santa Rosa WTG - Gas	267,202.561	Natural Gas	3,078,219	87,113,587.51	48.00	0.000768	0.0561	0.6742	37.50%	267,203	180,157
	TV Ventanilla GN CC	2,830,066.746	Natural Gas	19,105,686	540,690,920.30	48.00	0.000768	0.0561	0.3951	37.50%	2,830,067	1,118,187
	TV Ventanilla D2	6,890.962	Diesel	608,831	2,767.81	43.00	0.837	0.0741	1.0712	39.00%	6,891	7,382
	Sta Rosa TG8	948,267.861	Natural Gas	9,337,653	264,255,583.37	48.00	0.000768	0.0561	0.5763	37.50%	948,268	546,499
	TG Santa Rosa UTI - D2	10,657.288	Diesel	1,077,517	4,898.50	43.00	0.837	0.0741	1.2258	39.00%	10,657	13,064
	TG Santa Rosa UTI - Gas	104,472.600	Natural Gas	1,303,189	36,880,245.71	48.00	0.000768	0.0561	0.7301	37.50%	104,473	76,271
	Malacas TG1	47,134.226	Natural Gas	775,563	21,948,420.45	48.00	0.000768	0.0561	0.9630	37.50%	47,134	45,391
	Malacas TG2	47.959	Natural Gas	1,424	40,305.99	48.00	0.000768	0.0561	1.7381	37.50%	48	83
	Malacas TG4	457,401.478	Natural Gas	5,381,135	152,286,110.06	48.00	0.000768	0.0561	0.6885	37.50%	457,401	314,938
	Chilina	19,226.431	Diesel	1,568,951	7,132.61	43.00	0.837	0.0741	0.9894	39.00%	19,226	19,022
	Mollendo	79.107	Diesel	10,842	49.29	43.00	0.837	0.0741	1.6617	39.00%	79	131
	Pisco TG1	61,890.878	Natural Gas	704,662	19,941,948.06	48.00	0.000768	0.0561	0.6664	37.50%	61,891	41,241
	Pisco TG2	200,907.092	Natural Gas	2,336,923	66,134,921.69	48.00	0.000768	0.0561	0.6808	37.50%	200,907	136,772
	GD Chiclayo Oeste	14,666.667	Diesel	1,097,556	4,989.60	43.00	0.837	0.0741	0.9073	39.00%	14,667	13,307
	Piura	5,819.062	Diesel	435,335	1,979.08	43.00	0.837	0.0741	0.9070	39.00%	5,819	5,278
	TG Chimbote	26,127.608	Diesel	2,806,363	12,758.01	43.00	0.837	0.0741	1.3023	39.00%	26,128	34,025
	TG Piura	22,130.789	Diesel	2,563,978	11,656.10	43.00	0.837	0.0741	1.4047	39.00%	22,131	31,086
	Las Flores	513,705.872	Natural Gas	5,088,658	144,009,007.45	48.00	0.000768	0.0561	0.5797	37.50%	513,706	297,821
	Dolorespata	169.270	Diesel	16,265	73.94	43.00	0.837	0.0741	1.1650	39.00%	169	197
	Independencia	149,407.986	Natural Gas	1,241,009	35,120,559.03	48.00	0.000768	0.0561	0.4861	37.50%	149,408	72,632
	Emergencia Trujillo D2	881.354	Diesel	66,116	300.57	43.00	0.837	0.0741	0.9095	39.00%	881	802
	Emergencia Piura D2	103,451.052	Diesel	7,423,557	33,748.23	43.00	0.837	0.0741	0.8700	39.00%	103,451	90,004
	Emergencia Mollendo D2	26,135.719	Diesel	1,894,708	8,613.53	43.00	0.837	0.0741	0.8789	39.00%	26,136	22,972
	Tumbes MAK1, MAK2	10,305.410	Diesel	610,601	2,775.85	43.00	0.837	0.0741	0.7184	39.00%	10,305	7,403
	Chilca TG1	972,764.281	Natural Gas	9,359,638	264,877,766.50	48.00	0.000768	0.0561	0.5631	37.50%	972,764	547,786
	Chilca TG2	922,247.388	Natural Gas	8,795,698	248,918,239.49	48.00	0.000768	0.0561	0.5582	37.50%	922,247	514,780
	Chilca TG3	957,488.273	Natural Gas	9,523,294	269,509,211.63	48.00	0.000768	0.0561	0.5821	37.50%	957,488	557,364
	TV Chilca GN CC	1,369,244.819	Natural Gas	9,613,039	272,048,999.00	48.00	0.000768	0.0561	0.4109	37.50%	1,369,245	562,616
	Ilo Catkato	1,996.293	Diesel	130,767	594.48	43.00	0.837	0.0741	0.7942	39.00%	1,996	1,585
	Ilo TG	21,710.677	Diesel	1,891,357	8,598.30	43.00	0.837	0.0741	1.0562	39.00%	21,711	22,931
	Ilo TVs	82,628.239	Diesel	5,150,328	23,413.91	43.00	0.837	0.0741	0.7557	39.00%	82,628	62,443
	Ilo2 TV1	555,505.843	Coal	221,461	NA	28.20		0.0946	1.0635	39.00%	555,506	590,797
	Kallpa TG1	715,120.221	Natural Gas	7,145,284	202,211,549.94	48.00	0.000768	0.0561	0.5848	37.50%	715,120	418,188
	Kallpa TG2	777,093.333	Natural Gas	7,766,767	219,799,505.29	48.00	0.000768	0.0561	0.5850	37.50%	777,093	454,561
	Kallpa TG3	725,677.085	Natural Gas	7,201,998	203,816,548.94	48.00	0.000768	0.0561	0.5808	37.50%	725,677	421,507
	TV Kallpa GN CC	2,066,110.468	Natural Gas	14,095,400	398,899,816.52	48.00	0.000768	0.0561	0.3993	37.50%	2,066,110	824,953
	Bellavista	100.137	Diesel	11,686	53.13	43.00	0.837	0.0741	1.4149	39.00%	100	142
	Taparachi	964.962	Diesel	83,629	380.18	43.00	0.837	0.0741	1.0507	39.00%	965	1,014
	Tablazo	91,631.664	Natural Gas	913,178	25,842,946.37	48.00	0.000768	0.0561	0.5833	37.50%	91,632	53,445
	Oquendo	241,255.748	Natural Gas	2,432,586	68,842,187.61	48.00	0.000768	0.0561	0.5901	37.50%	241,256	142,370
	Cummins	392.551	Diesel	21,661	98.47	43.00	0.837	0.0741	0.6690	39.00%	393	263
	San Nicolás TVs	17,286.317	Diesel	1,481,718	6,736.04	43.00	0.837	0.0741	1.0392	39.00%	17,286	17,965
	TG1 Aguaytía	464,933.796	Natural Gas	5,870,833	166,144,565.78	48.00	0.000768	0.0561	0.7390	37.50%	464,934	343,599
	TG2 Aguaytía	423,211.911	Natural Gas	5,388,534	152,495,502.78	48.00	0.000768	0.0561	0.7452	37.50%	423,212	315,371
	TOTAL	**16,250,050**										**8,945,366**

Sources	**Document**	COES_Estadística de Operaciones_2011	COES_Estadística de Operaciones_2011	COES_Estadística de Operaciones_2011	N/A	IPCC 2006 Vol 2	"The Energy and Fuel Data Sheet" Iain Staffell, University of Birmingham, UK	IPCC 2006 Vol 2	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Appendix 1 of the "Tool to calculate the emission factor for an electricity system" version 4.0	COES_Estadística de Operaciones_2011	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Webpage	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	Calculated to convert from ft3 or gal to m3	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	http://www.claverton-energy.com/wp-content/uploads/2012/08/the_energy_and_fuel_data_sheet.pdf	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	Calculated as per Equation 2 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Default	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	Calculated as per Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Table (page)	Table N° 6.2 (59)	Table N° 6.2 (59)	Table N° 6.2 (59)	N/A	Table 1.2 (1.19)	Page 2	Table 1.4 (1.25)	Calculated	Appendix 1 (33)	Table N° 6.2 (59)	Calculated
	Power Plant	**EG_{2011} [MWh]**	**Fuel Type**	**FCi Natural Gas [1000ft3] Diesel [gal] Coal [ton]**	**FCi [m³]**	**NCVi [GJ/ton]**	**Density [ton/m³]**	**EF_{CO2} [tCO2/GJ]**	**$EF_{EL,m,y}$ [t CO2/MWh]**	**$\eta_{m,y}$ (%)**	**EGm,y (MWh)**	**$EF_{EL,m,y} * EG_{m,y}$**
2011	TG Santa Rosa WTG - D2	1,723	Diesel	164,727	748.87	43.00	0.837	0.0741	1.1591	39.00%	1,723	1,997
	TG Santa Rosa WTG - Gas	93,452	Natural Gas	1,064,603	30,128,272.06	48.00	0.000768	0.0561	0.6667	37.50%	93,452	62,307
	TV Ventanilla GN CC	3,435,873	Natural Gas	23,041,184	652,065,519.57	48.00	0.000768	0.0561	0.3925	37.50%	3,435,873	1,348,517
	Sta Rosa TG8	971,634	Natural Gas	9,434,828	267,005,630.30	48.00	0.000768	0.0561	0.5683	37.50%	971,634	552,186
	TG Santa Rosa UTI - D2	1,274	Diesel	64,681	294.05	43.00	0.837	0.0741	0.6154	37.50%	1,274	784
	TG Santa Rosa UTI - Gas	112,249	Natural Gas	1,434,999	40,610,482.15	48.00	0.000768	0.0561	0.7482	37.50%	112,249	83,985
	Malacas TG1	49,727	Natural Gas	845,313	23,922,370.64	48.00	0.000768	0.0561	0.9949	37.50%	49,727	49,473
	Malacas TG4	653,905	Natural Gas	7,226,605	204,512,922.07	48.00	0.000768	0.0561	0.6468	37.50%	653,905	422,947
	Chilina	19,259	Diesel	1,325,161	6,024.31	43.00	0.837	0.0741	0.8343	37.50%	19,259	16,066
	Mollendo	10,326	Diesel	631,583	2,871.24	43.00	0.837	0.0741	0.7416	37.50%	10,326	7,657
	Pisco TG1	139,304	Natural Gas	1,623,207	45,936,750.41	48.00	0.000768	0.0561	0.6820	37.50%	139,304	95,000
	Pisco TG2	161,760	Natural Gas	1,909,635	54,042,680.21	48.00	0.000768	0.0561	0.6909	37.50%	161,760	111,764
	GD Chiclayo Oeste	19,815	Diesel	1,448,434	6,584.73	43.00	0.837	0.0741	0.8863	37.50%	19,815	17,561
	Piura	11,289	Diesel	876,614	3,985.17	43.00	0.837	0.0741	0.9415	37.50%	11,289	10,628
	TG Chimbote	12,163	Diesel	1,355,696	6,163.13	43.00	0.837	0.0741	1.3514	37.50%	12,163	16,437
	TG Piura	36,837	Diesel	4,372,320	19,877.00	43.00	0.837	0.0741	1.4391	37.50%	36,837	53,011
	Las Flores	296,400	Natural Gas	2,883,584	81,605,418.44	48.00	0.000768	0.0561	0.5694	37.50%	296,400	168,766
	Independencia	97,352	Natural Gas	799,688	22,631,162.39	48.00	0.000768	0.0561	0.4808	37.50%	97,352	46,803
	Trujillo Norte	151,774	Diesel	10,925,322	49,667.61	43.00	0.837	0.0741	0.8727	37.50%	151,774	132,460
	Tumbes MAK1, MAK2	24,865	Diesel	1,481,203	6,733.70	43.00	0.837	0.0741	0.7222	37.50%	24,865	17,958
	Chilca TG1	1,001,322	Natural Gas	9,532,170	269,760,423.57	48.00	0.000768	0.0561	0.5571	37.50%	1,001,322	557,884
	Chilca TG2	1,001,797	Natural Gas	9,604,335	271,802,671.53	48.00	0.000768	0.0561	0.5611	37.50%	1,001,797	562,107
	Chilca TG3	827,423	Natural Gas	8,102,090	229,289,150.40	48.00	0.000768	0.0561	0.5731	37.50%	827,423	474,186
	Ilo Catkato	1,272	Diesel	82,276	374.03	43.00	0.837	0.0741	0.7840	37.50%	1,272	998
	Ilo TG	12,961	Diesel	1,106,376	5,029.69	43.00	0.837	0.0741	1.0349	37.50%	12,961	13,414
	Ilo TVs	208,401	Diesel	11,869,317	53,959.10	43.00	0.837	0.0741	0.6905	37.50%	208,401	143,905
	Ilo2 TV1	732,361	Coal	289,091	NA	28.20		0.0946	1.0531	39.00%	732,361	771,215
	Kallpa TG1	1,096,104	Natural Gas	10,688,748	302,491,563.56	48.00	0.000768	0.0561	0.5707	37.50%	1,096,104	625,574
	Kallpa TG2	1,359,037	Natural Gas	13,137,157	371,781,537.15	48.00	0.000768	0.0561	0.5657	37.50%	1,359,037	768,870
	Kallpa TG3	1,538,511	Natural Gas	14,821,829	419,457,754.30	48.00	0.000768	0.0561	0.5638	37.50%	1,538,511	867,468
	Bellavista	135	Diesel	11,131	50.60	43.00	0.837	0.0741	0.9970	37.50%	135	135
	Taparachi	699	Diesel	62,858	285.76	43.00	0.837	0.0741	1.0900	37.50%	699	762
	Oquendo	134,676	Natural Gas	1,368,186	38,719,668.32	48.00	0.000768	0.0561	0.5946	37.50%	134,676	80,075
	Cummins	173	Diesel	12,748	57.95	43.00	0.837	0.0741	0.8950	37.50%	173	155
	San Nicolás TVs	21,487	Diesel	2,057,874	9,355.30	43.00	0.837	0.0741	1.1612	37.50%	21,487	24,950
	TG1 Aguaytía	383,120	Natural Gas	5,170,441	146,323,476.84	48.00	0.000768	0.0561	0.7898	37.50%	383,120	302,607
	TG2 Aguaytía	105,543	Natural Gas	1,421,575	40,230,561.38	48.00	0.000768	0.0561	0.7883	37.50%	105,543	83,200
	TOTAL	**14,726,002**										**8,493,814**

Sources												
Sources	Document	COES_Estadística de Operaciones_2010	COES_Estadística de Operaciones_2010	COES_Estadística de Operaciones_2010	N/A	IPCC 2006 Vol 2	"The Energy and Fuel Data Sheet" Iain Staffell, University of Birmingham, UK	IPCC 2006 Vol 2	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Appendix 1 of the "Tool to calculate the emission factor for an electricity system" version 4.0	COES_Estadística de Operaciones_2010	"Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Webpage	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	Calculated	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	http://www.claverton-energy.com/wp-content/uploads/2012/08/the_energy_and_fuel_data_sheet.pdf	http://www.ipcc.ch/meetings/session25/doc4a4b/vol2.pdf	Calculated as per Equation 2 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"	Default	http://www.coes.org.pe/wcoes/coes/salaprensa/estadistica_anual.aspx	Calculated as per Equation 8 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"
	Table (page)	Table N° 4.2 (25)	Table N° 4.2 (25)	Table N° 4.2 (25)	Calculated	Table 1.2 (1.19)	Page 2	Table 1.4 (1.25)	Calculated	Appendix 1 (33)	Table N° 4.2 (25)	Calculated
2010	Power Plant	EG_{2010} [MWh]	Fuel Type	FCi Natural Gas [1000ft3] Diesel [gal] Coal [ton]	FCi [m^3]	NCVi [GJ/ton]	Density [ton/m³]	EF_{CO2} [tCO2/GJ]	$EF_{EL,m,y}$ [t CO2/MWh]	$\eta_{m,y}$ (%)	EGm,y (MWh)	$EF_{EL,m,y}$* $EG_{m,y}$
	TG Santa Rosa WTG - Gas	86,410	Natural Gas	964,837	27,304,886.82	48.00	0.000768	0.0561	0.6535	37.50%	86,410	56,468
	TV Ventanilla GN CC	3,214,070	Natural Gas	21,780,097	616,376,758.68	48.00	0.000768	0.0561	0.3966	37.50%	3,214,070	1,274,711
	TV Ventanilla D2	570	Diesel	51,731	235.17	43.00	0.837	0.0741	1.1003	37.50%	570	627
	Sta Rosa TG8	763,860	Natural Gas	7,538,844	213,349,296.24	48.00	0.000768	0.0561	0.5776	37.50%	763,860	441,221
	TG Santa Rosa UTI - Gas	55,860	Natural Gas	737,799	20,879,717.64	48.00	0.000768	0.0561	0.7730	37.50%	55,860	43,181
	Malacas TG1	48,430	Natural Gas	817,287	23,129,228.04	48.00	0.000768	0.0561	0.9877	37.50%	48,430	47,833
	Malacas TG2	17,920	Natural Gas	307,742	8,709,102.00	48.00	0.000768	0.0561	1.0051	37.50%	17,920	18,011
	Malacas TG4	617,320	Natural Gas	6,937,179	196,322,176.74	48.00	0.000768	0.0561	0.6577	37.50%	617,320	406,008
	Chilina	41,530	Diesel	3,155,248	14,344.07	43.00	0.837	0.0741	0.9211	37.50%	41,530	38,255
	Mollendo	60,410	Diesel	3,538,535	16,086.53	43.00	0.837	0.0741	0.7102	37.50%	60,410	42,902
	Pisco TG1	3,600	Natural Gas	42,488	1,202,416.91	48.00	0.000768	0.0561	0.6907	37.50%	3,600	2,487
	Pisco TG2	10,200	Natural Gas	120,161	3,400,569.04	48.00	0.000768	0.0561	0.6895	37.50%	10,200	7,033
	GD Chiclayo Oeste	23,720	Diesel	1,697,484	7,716.93	43.00	0.837	0.0741	0.8676	37.50%	23,720	20,581
	Piura	15,740	Diesel	1,195,791	5,436.19	43.00	0.837	0.0741	0.9211	37.50%	15,740	14,498
	TG Chimbote	8,070	Diesel	900,598	4,094.21	43.00	0.837	0.0741	1.3530	37.50%	8,070	10,919
	TG Piura	10,970	Diesel	1,277,764	5,808.84	43.00	0.837	0.0741	1.4122	37.50%	10,970	15,492
	Las Flores	13,080	Natural Gas	62,481	1,768,212.58	48.00	0.000768	0.0561	0.2796	37.50%	13,080	3,657
	Trujillo Norte	120,970	Diesel	8,989,749	40,868.30	43.00	0.837	0.0741	0.9010	37.50%	120,970	108,993
	Tumbes MAK1, MAK2	47,570	Diesel	2,782,873	12,651.22	43.00	0.837	0.0741	0.7093	37.50%	47,570	33,740
	Yarinacocha	2,590	Diesel	170,924	777.04	43.00	0.837	0.0741	0.8001	37.50%	2,590	2,072
	Chilca TG1	1,092,950	Natural Gas	10,536,129	298,172,453.25	48.00	0.000768	0.0561	0.5642	37.50%	1,092,950	616,642
	Chilca TG2	406,190	Natural Gas	4,023,063	113,852,670.17	48.00	0.000768	0.0561	0.5797	37.50%	406,190	235,455
	Chilca TG3	930,460	Natural Gas	9,153,561	259,045,769.23	48.00	0.000768	0.0561	0.5758	37.50%	930,460	535,725
	Ilo Catkato	3,370	Diesel	217,857	990.40	43.00	0.837	0.0741	0.7838	37.50%	3,370	2,641
	Ilo TG	36,800	Diesel	3,025,182	13,752.78	43.00	0.837	0.0741	0.9967	37.50%	36,800	36,678
	Ilo TVs	459,330	Diesel	31,273,810	142,173.87	43.00	0.837	0.0741	0.8255	37.50%	459,330	379,168
	Ilo2 TV1	1,066,920	Coal	393,153	NA	28.20		0.0946	0.9830	39.00%	1,066,920	1,048,823
	Kallpa TG1	880,430	Natural Gas	8,486,211.64	240,159,789.41	48.00	0.000768	0.0561	0.5641	37.50%	880,430	496,667
	Kallpa TG2	1,252,340	Natural Gas	12,198,212	345,209,398.75	48.00	0.000768	0.0561	0.5701	37.50%	1,252,340	713,917
	Kallpa TG3	1,078,300	Natural Gas	10,457,307	295,941,781.03	48.00	0.000768	0.0561	0.5676	37.50%	1,078,300	612,028
	Bellavista	160	Diesel	12,765	58.03	43.00	0.837	0.0741	0.9673	37.50%	160	155
	Taparachi	1,260	Diesel	102,193	464.58	43.00	0.837	0.0741	0.9833	37.50%	1,260	1,239
	Oquendo	203,600	Natural Gas	2,078,636	58,825,402.48	48.00	0.000768	0.0561	0.5975	37.50%	203,600	121,655
	Cummins	80	Diesel	6,016	27.35	43.00	0.837	0.0741	0.9117	37.50%	80	73
	San Nicolás TVs	38,450	Diesel	3,696,966	16,806.78	43.00	0.837	0.0741	1.1657	37.50%	38,450	44,823
	TG1 Aguaytía	318,240	Natural Gas	4,133,684	116,983,246.73	48.00	0.000768	0.0561	0.7602	37.50%	318,240	241,930
	TG2 Aguaytía	446,690	Natural Gas	5,794,738	163,991,078.04	48.00	0.000768	0.0561	0.7592	37.50%	446,690	339,145
	Independencia	5,270	Natural Gas	43,808	1,239,758.76	48.00	0.000768	0.0561	0.4865	37.50%	5,270	2,564
	Dolorespata	330	Diesel	31,039	141.11	43.00	0.837	0.0741	1.1404	37.50%	330	376
	TOTAL	**13,384,060**										**8,018,392**

Step 5 - Calculate the build margin (BM) emission factor

In terms of vintage of data, project participant has selected **Option 1.** For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. This option does not require monitoring the emission factor during the crediting period.

The sample group of power units *m* used to calculate the build margin is determined as per the following procedures:

a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);
b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%)}$ and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%,}$ in MWh);
c) From SET5-units and SET≥20% select the set of power units that comprises the larger annual electricity generation (SETsample); Identify the date when the power units in SETsample started to supply electricity to the grid. If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SETsample to calculate the build margin. In this case ignore steps (d), (e) and (f).

Out of $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$, the latter group was selected as $SETs_{ample}$ due to the fact that it includes the larger annual electricity generation. Moreover, none of these power plants started to supply energy to the grid more than ten years ago.

The following table shows the capacity additions to the SEIN (2000-2012):

Table 10. Capacity additions to the SEIN (2000-2012)[41]

Plant Name	Generation (GWh) in 2012 (1)			TOTAL 2012 Generation (GWh) (1)	Start Operation (2)	CDM Project
	Hydro	Thermo	Solar			
C.T. PARAMONGA		92.78		92.78	17/03/2010	No
C.H. PÍAS (1)	87.20			87.20	01/11/2011	Yes
C.H. PLATANAL	1,222.77			1,222.77	31/03/2010	Yes
C.H. HUANCHOR	148.91			148.91	06/11/2002	No
C.T. SANTA ROSA		1,346.24		1,346.24	01/06/2005	Yes
C.T. VENTANILLA		2,836.96		2,836.96	19/07/2006	Yes
C.T. MOLLENDO		0.08		0.08	01/05/2012	No
C.T. PISCO		262.80		262.80	03/09/2010	No
C.H. MACHUPICCHU	736.20			736.20	07/06/2001	No
C.T. DOLORESPATA		0.17		0.17	29/01/2010	No
C.H. CAÑA BRAVA	30.68			30.68	19/02/2009	Yes
C.H. CARHUAQUERO	518.17			518.17	22/05/2008	No
C.H. CARHUAQUERO IV	74.35			74.35	22/05/2008	Yes
C.T. CHICLAYO OESTE (21)		14.67		14.67	24/05/2008	No
C.T. CHIMBOTE		26.13		26.13	23/08/2011	No
C.T. LAS FLORES		513.71		513.71	17/05/2010	No
C.T. INDEPENDENCIA		149.41		149.41	02/10/2010	No
C.T. EMERGENCIA MOLLENDO		26.14		26.14	01/05/2012	No
C.T. EMERGENCIA PIURA		103.45		103.45	15/06/2012	No
C.T. EMERGENCIA TRUJILLO		0.88		0.88	07/07/2009	No
C.T. TUMBES		10.31		10.31	28/02/2001	No
C.H. YUNCAN	898.34			898.34	24/08/2005	No
C.T. CHILCA		4,221.74		4,221.74	11/12/2006	No
C.H. LA JOYA	69.92			69.92	01/10/2009	Yes
C.H. NUEVA IMPERIAL	11.72			11.72	20/04/2012	Yes
C.T. KALLPA		4,284.00		4,284.00	01/07/2007	Yes
C.H. RONCADOR	15.18			15.18	28/04/2010	No
C.S. MAJES			22.67	22.67	31/10/2012	Yes
C.T. MAPLE ETANOL		40.67		40.67	17/08/2012	Yes
C.S. PANAMERICANA SOLAR			1.32	1.32	31/12/2012	Yes
C.TB. HUAYCOLORO		29.36		29.36	12/11/2011	Yes
C.S. REPARTICIÓN			23.31	23.31	31/10/2012	Yes
C.H. HUASAHUASI I	43.21			43.21	12/01/2012	Yes
C.H. HUASAHUASI II	26.95			26.95	18/04/2012	Yes
C.H. SANTA CRUZ I	15.80			15.80	19/02/2009	Yes
C.H. SANTA CRUZ II	19.28			19.28	14/05/2010	Yes
C.H. PURMACANA	5.07			5.07	18/03/2011	Yes
C.T. TABLAZO		91.63		91.63	01/09/2012	No
C.T. OQUENDO		241.26		241.26	06/03/2009	No
C.T. SAN NICOLÁS		17.68		17.68	26/07/2001	No
C.H. POECHOS II	59.49			59.49	30/04/2010	Yes
C.H. MISAPUQUIO	30.21			30.21	02/04/2003	No
C.H. OROYA	60.88			60.88	20/11/2004	No
C.H. SAN ANTONIO	3.34			3.34	02/04/2003	No
C.H. SAN IGNACIO	2.16			2.16	02/04/2003	No
C.S. TACNA SOLAR			12.40	12.40	31/10/2012	Yes

[41] Sources (1) and (2) of the Table:
(1) Source: COES. Estadistica de Operaciones 2012. Table N° 5.6 , page 45-46 of "COES_Estadística de Operaciones_2012"
(2) Source: COES. Estadistica de Operaciones 2012. Table N° 3.8 , page 32 of "COES_Estadística de Operaciones_2012"

In the table above it can be seen that most of the additions to the SEIN are thermal generation units; and that even the larger power plants are thermal.

However, to identify the SET_{sample} power plants ($SET_{5\text{-units}}$, $SET_{\geq 20\%}$) and calculate the BM, the CDM registered projects should be excluded and therefore the set of five power plants built most recently that are considered to calculate the BM are:

1. C.T. MOLLENDO
2. C.T. CHIMBOTE
3. C.T. EMERGENCIA MOLLENDO
4. C.T. EMERGENCIA PIURA
5. C.T. TABLAZO

The $SET_{5\text{-units}}$ power plants have an annual generation of 247.346 GWh, which represents 0.66% of the total annual generation (37,321,200 GWh). The annual generation of $SET_{\geq 20\%}$ power plants is 8,168.53 GWh, which represents 21.89%; therefore the second group was selected to calculate the BM. In the following table it is shown how the SETsample power plants have been chosen to calculate the BM:

Table 11. Selection of SET_{sample} Power Plants

Date of Entry To SEIN	Power Plant	$EF_{EL,m,y}$ (tCO_2/MWh)	Most recent year generation	$SET_{\geq 20\%}$	$AEG_{SET\geq 20\%}$ (GWh)	$SET_{5\text{-units}}$	$AEG_{SET\text{-}5\text{-units}}$ (GWh)
17/03/2010	C.T. PARAMONGA	-	92.78	1	92.780		-
06/11/2002	C.H. HUANCHOR	-	148.91	1	148.915		
01/05/2012	C.T. MOLLENDO	1.662	0.08	1	0.079	1	0.079
03/09/2010	C.T. PISCO	0.681	262.80	1	262.798		-
07/06/2001	C.H. MACHUPICCHU	-	736.20	1	736.202		-
29/01/2010	C.T. DOLORESPATA	1.165	0.17	1	0.169		-
22/05/2008	C.H. CARHUAQUERO	-	518.17	1	518.166		-
24/05/2008	C.T. CHICLAYO OESTE (21)	0.907	14.67	1	14.667		-
23/08/2011	C.T. CHIMBOTE	1.302	26.13	1	26.128	1	26.128
17/05/2010	C.T. LAS FLORES	0.580	513.71	1	513.706		-
02/10/2010	C.T. INDEPENDENCIA	0.486	149.41	1	149.408		-
01/05/2012	C.T. EMERGENCIA MOLLENDO	0.879	26.14	1	26.136	1	26.136
15/06/2012	C.T. EMERGENCIA PIURA	0.907	103.45	1	103.451	1	103.451
07/07/2009	C.T. EMERGENCIA TRUJILLO	0.910	0.88	1	0.881		-
28/02/2001	C.T. TUMBES	0.718	10.31	1	10.305		-
24/08/2005	C.H. YUNCAN	-	898.34	1	898.342		-
11/12/2006	C.T. CHILCA	0.582	4,221.74	1	4,221.745		-
28/04/2010	C.H. RONCADOR	-	15.18	1	15.178		-
01/09/2012	C.T. TABLAZO	0.583	91.63	1	91.632	1	91.632
06/03/2009	C.T. OQUENDO	0.590	241.26	1	241.256		-
02/04/2003	C.H. MISAPUQUIO		30.21	1	30.206		-
20/11/2004	C.H. OROYA		60.88	1	60.881		-
02/04/2003	C.H. SAN ANTONIO		3.34	1	3.341		-
02/04/2003	C.H. SAN IGNACIO		2.16	1	2.156		-
TOTAL				**24**	**8,168.527**	**5**	**247.346**

To calculate the BM, the selected set of plants ($SET_{\geq 20\%}$) was organized according to their annual generation output (the annual generation was provided by COES[42] in its annual report of 2012) and the corresponding emission factor (emission factor of power plants included in the BM) is calculated using option A2 for the simple OM. The Build Margin emissions factor (BM) is calculated as the generation-weighted average emission factor of the most recently built plants, using the following formula:

[42] COES. Estadistica de Operaciones 2012. Table N° 5.6 , page 45-46 of "COES_Estadística de Operaciones_2012"

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

Equation 13 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0"

Where:

$EF_{grid,BM,y}$ = Build margin CO2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m = Power units included in the build margin
y = Most recent historical year for which power generation data is available

The power units included in the build margin m correspond to the sample group $SET_{\geq 20\%,}$ as per the following table:

Table 12. BM Calculation

Power Plant	**SET_{sample} (MWh)**	**$EF_{EL,m,y}$ (tCO_2/MWh)**
C.T. PARAMONGA	92,780.49	0.00000
C.H. HUANCHOR	148,914.84	0.00000
C.T. MOLLENDO	79.11	1.66167
C.T. PISCO	262,797.97	0.68077
C.H. MACHUPICCHU	736,201.75	0.00000
C.T. DOLORESPATA	169.27	1.16497
C.H. CARHUAQUERO	518,165.70	0.00000
C.T. CHICLAYO OESTE (21)	14,666.67	0.90729
C.T. CHIMBOTE	26,127.61	1.30225
C.T. LAS FLORES	513,705.87	0.57975
C.T. INDEPENDENCIA	149,407.99	0.48613
C.T. EMERGENCIA MOLLENDO	26,135.72	0.87894
C.T. EMERGENCIA PIURA	103,451.05	0.90703
C.T. EMERGENCIA TRUJILLO	881.35	0.90951
C.T. TUMBES	10,305.41	0.71836
C.H. YUNCAN	898,342.20	0.00000
C.T. CHILCA	4,221,744.76	0.58211
C.H. RONCADOR	15,177.94	0.00000
C.T. TABLAZO	91,631.66	0.58326
C.T. OQUENDO	241,255.75	0.59012
C.H. MISAPUQUIO	30,205.85	0.00000
C.H. OROYA	60,881.31	0.00000
C.H. SAN ANTONIO	3,340.90	0.00000
C.H. SAN IGNACIO	2,156.12	0.00000

Applying the Equation 13 of the "Tool to Calculate the Emission Factor for an Electricity System, Version 4.0" to the above values of each plant, the folloing results are obtained:

Parameter	Value	Units
$\Sigma EG_{m,2012} X EF_{EL,m,2012}$	3,375,365	tCO_2
$\Sigma EG_{m,2012}$	8,168,527	MWh
$\boldsymbol{EF_{grid,BM,2012}}$	**0.41322**	(tCO_2/MWh)

As per the above table, the Build Margin Emission Factor calculated as per the "Tool to Calculate the Emission Factor for an Electricity System" (Version 4.0) results in **0.41322 tCO2/MWh.**[43]

Step 6 - Calculate the combined margin emissions factor

The final step in applying the tool is to calculate the combined margin emissions factor. This has been calculated as the weighted average of the emissions factor of the OM and the BM. The formula that has been used to calculate this weighted average emission factor is as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \qquad \text{Equation 5}$$

Where

- $EF_{grid, CM, y}$ = Combined margin CO_2 emission factor in year y (tCO_2/MWh)
- $EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)
- $EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh)
- w_{OM} = Weighting of operating margin emissions factor (%)
- w_{BM} = Weighting of build margin emissions factor (%)

As recommended by the tool for projects other than wind and solar projects, the default values of weighted factors for the second and third crediting period of w_{OM} = 0.25 w_{BM} = 0.75 are used.

For the fuels NCVs, official values when available and the latest default values recommended in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for fuels NCVs and emissions factors were used to derive the OM and the BM emission factors of the grid.

The results of the EF calculation are summarized below:

Table 13. CM Calculation

Parameter	Value	Units
$EF_{grid,OM-adj, 2010-2012}$	0.57388	tCO2/MWh
$EF_{grid,BM,2012}$	0.41322	tCO2/MWh
$\boldsymbol{EF_{grid, CM, y}}$	**0.45338**	**tCO2/MWh**

As per the above table, the Combined Margin Emission Factor $EF_{grid, CM, y}$ calculated as per the "Tool to Calculate the Emission Factor for an Electricity System" (Version 4.0) results in **0.45338 tCO2/MWh.**

[43] See detailed calculation in Excel Spreadsheet "EF_Peru_2012" provided to DOE

Appendix 5: Further background information on monitoring plan

Please refer to section B.7.

Appendix 6: Summary of post registration changes

No post registration changes have been conducted in the CDM-PDD of the 2nd Crediting Period.

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 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	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
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