Project design document form
(Version 11.0)

BASIC INFORMATION	
Title of the project activity	Fes New Landfill Gas Recovery Reuse and Flaring Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	16.1
Completion date of the PDD	22/12/2020
Project participants	1) Ecomed Gestion des Dechets 2) Commune Urbaine de Fes
Host Party	Morocco
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas Version 13.0.0
Sectoral scopes	13: Waste handling and disposal 1: Energy industries (renewable - / non-renewable sources)
Estimated amount of annual average GHG emission reductions	116,494 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

Project's Activities

The Project's activities include the installation of enhanced landfill gas extraction and flaring equipment for the destruction of the landfill gas and the installation of electricity generation (aggregating to 2.134 MW i.e., 1.067 MW * 2 units) equipment for the production of onsite electricity using also the landfill gas. Each and all of these activities involve the combustion of methane contained in the landfill gas, therefore, they will all lead to the reduction of greenhouse gas emissions. In general, the captured LFG will be utilized in the gas engines that will generate electricity and sell it to the grid after factoring the auxiliary consumption of the gas engines and project site. In the event, the LFG gas is in excess when gas engines are not operating, it will be combusted in the flare system.

The detailed technical specifications of the proposed CDM project activity components are included in further chapters of the PDD viz., Section A.3 Table 1. As of now, the gas collection system pipes for the LFG wells, one unit of enclosed flare system has been purchased by the project participant. There is one gas engine installed at site of 1.067 MW capacity. Therefore, initially after the registration of the project activity the flaring would be the key activity and based on internal evaluation the gas engines would be procured as per the need of 1.067 MW (2 units) aggregating up to 2.134 MW.

Pre-project Scenario

The pre project scenario is O&M of the landfill without utilizing the landfill gas in any manner. The existing landfill is managed with clay liner and leachate collection system and LFG is released into the atmosphere in controlled manner (through extended pipes). Though, there is no regulations existing in the country to burn the LFG thus generated and is neither covered under the scope of O&M agreement of landfill, it is still burnt randomly for almost 10 days stretching in a year to reduce the fire hazard. The number of days it is flared is recorded by the O&M contractor. The net electricity that will be generated in the project is currently being generated in the power plants connected to the national grid (to which the project will be connected) and GHG emissions occur on the same account. The leachate collected currently are left as such and gets sun dried.

The estimated annual average and the total CO_2e emission reduction by the project activity over the fixed crediting period of 10 years are expected to be 116,494 tCO_2e and 1,164,946 tCO_2e, respectively.

Project's Benefits

The Project will have several positive social and environmental impacts:

- First, the destruction of the LFG will improve the local environment by reducing the amount of noxious air pollution arising from the landfill, resulting in a considerable reduction of nuisance caused by the odors and also health risks associated to these emissions, especially for the surrounding population located nearby the landfill.
- Second, capturing and flaring landfill gas is an effective way of preventing the emission of methane into the atmosphere, thus reducing the release of gases having a potential greenhouse effect, and therefore minimizing contribution to global warming.
- Third, the project will provide a model for managing LFG, a key element in improving landfill management practices throughout the Host Country.
- Fourth, the Project will provide short- and long-term employment opportunities for local people. Local contractors and laborers will be required for construction, and long-term staff will be used to operate and maintain the system.
- Fifth, the sale of CERs earned by implementing the project will generate a substantial flow in foreign currency to the municipality. This income will be shared with the Government of the Province to promote new sustainable-development projects.
- Sixth, the Project will help the Host Country fulfil its goals of promoting sustainable development, uses clean and efficient technologies, and conserves natural resources;

In conclusion, the proposed project activity will, not only bring significant GHG emission reduction

benefits, but also can promote the transfer of the landfill gas recovery and utilization technologies and management experience to Morocco. In addition, the successful implementation of proposed project activity will greatly improve the local environment quality and contribute to local sustainable development as well.

A.2. Location of project activity

The project activity is located at Wilaya de Fes-Boulemane, Fes, Morocco.

The landfill site is located at about 11 km southeast of the city of Fes, Northeast of Morocco. The site is accessible through the secondary road RS No 320 leading to the town of Sidi Hrazem, and is located at approximately 1km from this secondary road near a village called Ouled M'Hammed. The exact Lambert coordinates of the site are

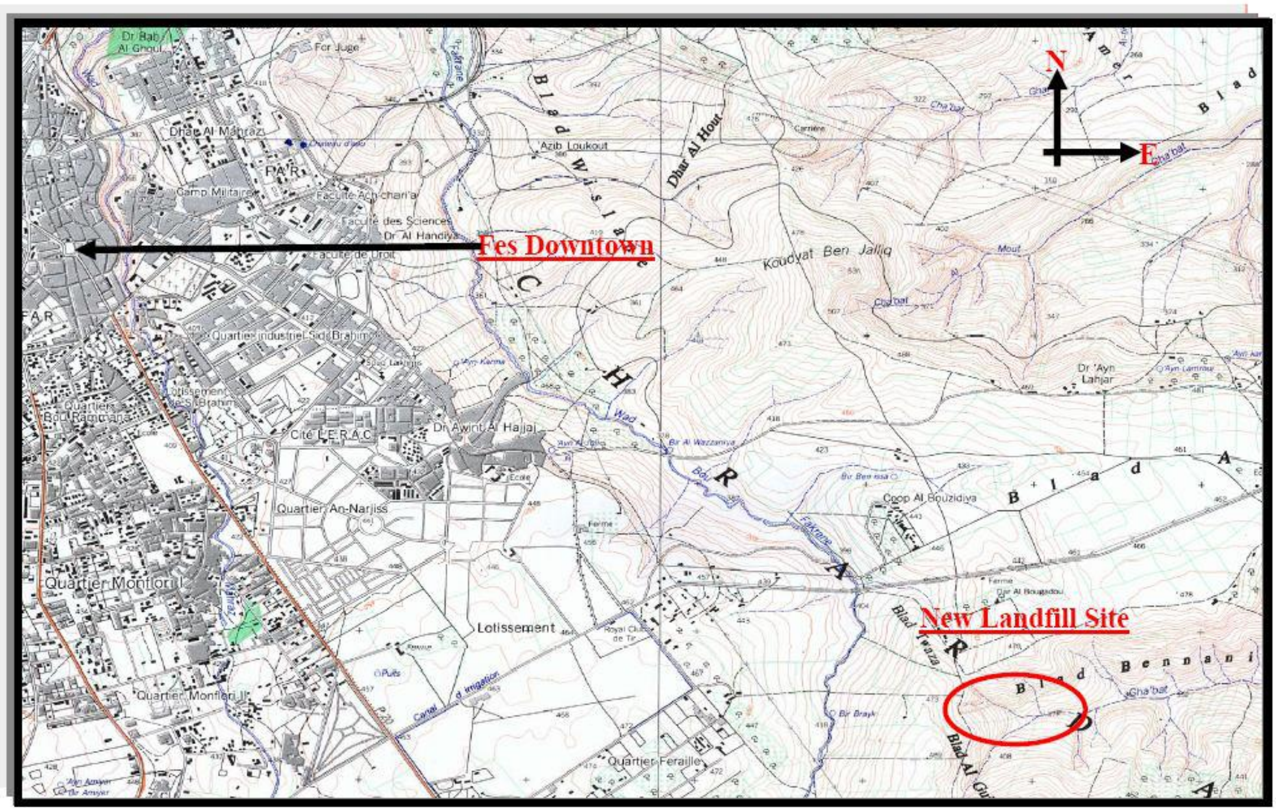
x = 544 ; y = 378.

The latitude and longitude coordinates of the site are:

34° 00' 20.7"N, 4° 56' 1.5"W.

In decimal system, the coordinates are +34.00575 and -4.93375 (as converted using website http://transition.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html). The site is located in a topographical depression. The geological cross section at the site is a clay formation with permeability of less than 10^{-7} cm/sec. The total available area for landfilling is 100 hectares and is divided into three cells. The first cell has been in operation since April 2004 and the estimated life expectancy of the landfill is 30 years.

Scale : 1/25000



A.3. Technologies/measures

The project participant is planning to install a Gas Recovery, Reuse and Flaring project with the following capacities:

Table 1: Project activity components

Unit	Number	Specifications
Gas extraction wells	40	-
Flares (1 Enclosed)	1	Flare dimension (W*L*H); 2229*8298*7434 (in mm) Stack Height Effective 6630 (in mm); Total 8805 (in mm) Flow rate (Min/Max); 500 – 2000 Nm^3/hr Temperature range Nominal operation 1000˚C to 1150 ˚C Maximum Temperature 1200 ˚C Destruction Efficiency at 1000 ˚C = 99.9%
Power Plant (Gas) Engines	01 01	1.067 MWe, currently installed at site 1.067 MWe, not yet installed, therefore aggregated capacity will not increase more than 2.134 MW
DG (as backup)	01	165 kW, for emergency backup when power can't be fetched from grid / gas engines.

Landfill Gas Collection System

The Project Developer has over twenty years of practical experience in the design, installation and

operation of LFG collection and utilization systems.
The gas collection field installation will be closely managed and monitored by experienced project managers from the Project Developer in accordance with proven Quality Assurance/ Quality Control (QA/QC) procedures. Experienced key workers are employed to ensure that the gas collection system is installed correctly. In addition, a comprehensive installation record will maintained to ensure that any future expansion or repair works can be located quickly and efficiently. The landfill gas collection system will include the following components:

- Horizontal Wells: In order to expedite the extraction of the LFG, horizontal drains will be installed in the waste mass. It is envisioned to install a series of horizontal drains with a horizontal separation distance of 75 meters installed every 7 meters in waste lift height. The horizontal drains will consist of perforated High Density Polyethylene (HDPE) pipes surrounded gravel or equivalent drainage material. The horizontal wells will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.
- Vertical Wells: Landfill gas vertical extraction wells will also be drilled into the landfill once cells reach their final elevation and final cover has been applied. The vertical wells consist of a perforated HDPE pipe, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. The vertical gas wells will be spaced on a site-specific grid to maximize LFG collection. The wells will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.
- Collection Piping: The gas collection pipe network will consists of HDPE pipes connecting groups of gas wells to the manifolds. Manifolds will connect into a main pipe and then into the main header pipe delivering the gas to the blower/flare/power station. The system will be modular, so it would be relatively easy to extend it on parts of the landfill available for gas extraction in the future.
- Condensate Management: The gas collection pipe work would allow for effective condensate management by installing dewatering points at strategic low points and returning the condensate back to landfill.
- Blowers: Blowers will be installed to draw the gas from the wells through the collection system and delivers it to the flare and/or gas fuelled internal combustion engine powering electricity generator.

The system will be optimized to address issues related to pressure losses. The gas collection system will be operated by the Project Developer's trained personnel. Their engineers and technicians will be involved in balancing the gas collection system on a regular basis in accordance with the monitoring plan. Sophisticated portable gas monitoring equipment, fitted with in-built data logging facility and data retrieval to a PC will be used in the day-to-day operation of the system. Project Developer's senior management personnel will provide technical support throughout the project to the local personnel employed on the ground.

Landfill Gas Flaring
The Project Developer has designed and installed skid / base mounted gas flares for burning LFG for over twenty years. Enclosed stacks provide conditions for high temperature combustion to effectively destruct methane with other combustible LFG components and meet low emission regulations in accordance with latest best practice guidelines in the USA.

The project activity involves the installation of a modular enclosed gas flare consisting of pipe work, valves, blower, stack with proprietary burners, instrumentation and control panel. In addition, a backup open flare equipped with a flame detection and flow reporting system will be provided. The main features of the gas flare system are presented below.

Piping: The pipe work will connect all the elements of the flare from the mains header pipe to the burners via a demister with filter element, isolation and control valves, blower and instrumentation. All the pipe work will be flanged or threaded connections and will be fully galvanized. The demister element protects the fan from moisture and particulates that flow with the gas from the waste deposit. The pipe work will have drainage valves for removal of condensate that may accumulate in it.

- Valves: Valves used will be manual or automatically operated. They can isolate incoming gas or parts of the pipe work in accordance with operational requirements. They will also be used to regulate the flow and pressure of the gas.
- Flame Arrestor: The unit will have a flame arrester for safety purposes. The flame arrester(s), which is of the deflagration type, will be fitted on the main and pilot delivery lines. The arresters protect the blower and the field pipe work from flashback of the flame from the burners.
- Blower: The system will include a centrifugal electrically-powered blower, which is a pressure rising machine that generates suction in the gas collection system and positive pressure (above atmospheric) on the burners. The blower will suck the gas from the gas wells into the burners.
- Flare Stack: The flare stack will be made of circular galvanized steel shroud with ceramic lining that maintains high combustion temperature inside. The dimensions of the stack will be designed to guarantee safe and effective destruction of the LFG with minimal environmental impact (low emissions). At the bottom of the stack will be a set of manual and automatic louvers that control air supply to the burners in order to maintain optimum combustion parameters. The stack will be fitted with an igniter that starts the flame on the burners, with a thermocouple (to measure temperature), and a flame detector.
- Burners: The burners will ensure full destruction of combustible constituents found in LFG at high temperature in accordance with the US Environment Protection Agency guidelines.
- Instrumentation: The unit will include sophisticated instrumentation, as follows:
    - flow meter to measure accurately the flow of the gas through the system;
    - gas analyzer (methane, carbon dioxide, oxygen) that measures the quality of the gas delivered to the flare, as well as gas flow rate and pressure (and other selected parameters);
    - sampling points for taking gas samples with portable instrumentation and for laboratory analysis;
    - ultraviolet camera fitted to the stack that monitors the presence of the flame;
    - thermocouple that monitors accurately the temperature of the flame in the stack and feeds back the signal to the automated air louver in order to maintain the temperature within the stack at desired level; and
- Control Panels: The control panel will house all of the flare controls, motor starters, alarms and interlocks that ensure safe operation of the flare. The control panel enables:
    - powering the plant and its components;
    - manual, automated or remote start and shut down of the flare;
    - automated shutdowns and isolation of the gas supply if the safety devices (e.g. flame detector) indicate unsafe operating conditions;
    - automatic notification of the alarms and shutdowns to the operator;
    - automated temperature control;
    - local readout of the flare operating parameters and alarms; and
    - electrical isolation of the whole plant.

The Project Developer will provide all the training necessary to the site manager and operators for the adequate use of the equipment and instrumentation described above as well as for the monitoring procedures required by the project. This training will be provided by specialized technicians from the USA and according to established operation and maintenance manuals developed for this purpose.

Electricity Generation

The project would install a maximum capacity of 2.134 MW electricity generation capacity (02 units of 1.067 MWe each) to produce electricity for on-site consumption and/or export to the grid, a modular reciprocating engine facility will be installed.

The Project Developer would develop the electricity generation component of the project activity through its relationship with the NERC Group, who has extensive experience in the design, building, and operation of generators using LFG.

The electricity generation project component will involve the construction of a suitable sized compound (30m x 30m) which will comprise of a level surface with concrete bases to support the engine units. The compound will have an electrical earthen blanket constructed below the surface to comply with electrical regulations. There will be an electrical sub-station constructed that will contain all suitable switching gear and metering equipment to facilitate a connection in the future to the national grid network. In addition, there will be a small support building for an office and a workshop. A series of pipes and ducts will be laid to carry both electrical cabling and gas pipe work. There will also be three fully bounded tanks for clean oil, dirty oil and coolant storage. The whole area will be securely fenced.

The packaged generation system will consist of an outdoor acoustic containerized generating set comprising an engine/alternator set. The engine units will consist of fully containerized Caterpillar turbocharged gas engine, with a separate control room and housing for its own transformer and switch. These units will be designed to be fully mobile. The containers will be fully sealed (no floor penetrations) to ensure no leaks of oil to ground, therefore environmentally friendly. As the gas production increases or decreases (gas production curve) then containerized engine units can be easily added or taken away to match the gas production. The design will incorporate the following key features:

- Fully enclosed oil-bounded engine compartment and control room;
- Extended oil sumps to increase oil change intervals and reduce downtime;
- Sealed oil pumping lines to make oil changes faster and safer with no risk of spillage;
- Sound proofed engine compartments, reducing sound levels;

Possibly, in the future, additional gensets for the production of electricity will be installed which will be interconnected to the local electricity power system.

Technology transfer:
The implementation of this project at the Fes Landfill Site, will bring the technological know-how to local team who installs and operate the system. Several training programs will be provided by the Project developer to the local staff. Technical support will be always available to help resolve any difficulties. Being the first of its kind in Morocco the project will attract many visitors from other municipalities who will be interested in implementing similar projects in their municipalities.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Morocco (host Party)	Private entity “Ecomed Gestion des Dechets”	No
Morocco (host Party)	Public entity “Commune Urbaine de Fes”	No

A.5. Public funding of project activity

The project sponsors has not received any public funding for the development of this project from Parties included in Annex I to the Convention or any other.

A.6. History of project activity

Project’s Background and History
The Fes Landfill is the first controlled landfill built in Morocco. The landfill is equipped with a clay liner, a leachate collection system, a stormwater management system, a computerized scale, two bulldozers, a loader, an excavator, a truck and other tools for monitoring and maintenance of the

landfill. The waste is compacted and covered on a daily basis and all the operational records of the landfill are maintained in a computerized information management system.

The landfill construction and operation were the subject of an international bid issued in 2001 by the Commune Urbaine of Fes. Three bidders participated in the bid, and the consortium comprised of the American company Edgeboro International Inc and the Moroccan Company Ecomed Gestion des Dechet won the bid. A contract agreement was then signed in December 2001 between the Commune Urbaine de Fes and the consortium Edgeboro-Ecomed to construct the landfill and operate it for a period of 10 years, later extended to 30 years.

The agreement did not include, however, any requirements for the landfill gas management and/or reuse (besides passive venting) due to the lack of national regulations and guidelines in this area at the time of contract negotiation and due also to the fact that such requirements would have induced higher costs making the landfill project unaffordable and unsustainable for the Commune Urbaine de Fes.

The Landfill was opened in April 2004, and started receiving municipal solid waste per year from the Urban District of Fes. After six months of operations, the landfill started to produce gas and this gas started to come out of the underlying leachate collection system. And although there was no regulatory requirement to deal with this gas, an internal decision was made by the project developer to temporary burn this gas for safety reasons. The burning of the gas took place on an average of 10 days per year through an open pipe extended from the leachate collection system. Meanwhile several alternatives were evaluated to deal with the overall landfill gas collection and treatment on a long term basis.

The first evaluated alternative included the use the gas to produce energy and sell it to the national or local electric utility company to generate revenues to pay for the cost of the needed active gas extraction and treatment system. This alternative, however, was not financially viable due to the high construction and operation cost of the proposed system and the low return due the relatively low subsidized cost of energy in Morocco. The LFG revenues (gas, electricity and/or heat) alone are insufficient to recover project investments and operational costs.

Another alternative was then proposed by the consortium and it consists of developing the project under the Clean Development Mechanism (CDM) program of the Kyoto Protocol in order to generate some revenues to offset part of the cost of the project by selling Certified Emission Reductions (CERs) earned by implementing the project. A change order dated 5 July 2006 to the original contract with the city was then sought by the project developer to collect and flare the landfill gas in the framework of CDM since the original contract included only the O&M of the landfill and not the collection or flaring of the LFG. This alternative is then the subject of the present application.

A.7. Debundling

Not applicable (for large scale projects).

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

For this project, the latest version of **Approved consolidated baseline and monitoring methodology ACM0001** “**Flaring or use of landfill gas**” Version 13.0.0, is being used.
The other methodological tools referred and applied in the PDD are as under;

- Emissions from solid waste disposal sites (Version 06.0.1)
- Combined tool to identify the baseline scenario and demonstrate additionality (Version 05.0.0)
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (Version 01)
- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 02)

- Project emissions from flaring (Version 02.0.0)
- Tool to calculate the emission factor for an electricity system (Version 03.0.0)
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0)

B.2. Applicability of methodologies and standardized baselines

The applied methodology ACM0001 Version 13.0.0 prescribes the applicability conditions as under:

ACM0001 Version 13.0.0 applicability conditions	**Justification**
This methodology is applicable to project activities which:	
(a) Install a new LFG capture system in a new or existing SWDS; or	The proposed CDM project activity involves installation of a new LFG capture system in an existing SWDS therefore applies with the condition.
(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:	The proposed CDM project activity does not aim at investing into existing LFG capture system but to install a new LFG capture system at the project site. The LFG capture system at the project site in the absence of the project activity means the vertical pipes only that are meant to give passage to LFG generated underneath. However, these systems are not intended or designed to capture the LFG for any useful purposes like flaring or utilizing in the gas engines. Therefore, the applicability condition is not relevant in case of the proposed CDM project activity. Therefore, its sub clauses are also not applicable/relevant.
(i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and	Not applicable
(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.*	Not applicable
(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:	The proposed CDM project activity would install the landfill capture system and utilize it for electricity generation and flaring purposes.
(i) Generating electricity;	Yes, the project will generate electricity using 02 gas engines of 1.067 MW capacity each.
(ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace; and/or	No, the project activity will not be generating heat.
(iii) Supplying the LFG to consumers through a natural gas distribution network.	No applicable
(d) Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.	The proposed CDM project do not affect the quantity of organic waste that is dumped on the landfill site. The intent of the project activity is to capture the LFG from the decay of organic matter that is dumped in this landfill. The contract to build and operate the controlled sanitary landfill was signed in Dec 2001, which

	was initially for a period of 10 years that was extended to 20 more years (making it 30 years)[1]. The contract[2] to operate the landfill obligates the delegator i.e. Fes Urban Community to provide the collected MSW to the landfill site. These terms and conditions were agreed well before the project start date of the proposed CDM project activity (in 2008). Therefore, the implementation of the project activity has no impact on the quantity of MSW that will reach it, anyhow. However, a typical practice before the MSW reaches landfill site (or thereafter) involves recovery[3] of articles e.g., Paper, Glass, Plastic, Metals, Fabric or rubber by informal sector considering the economic value of such items. It can be seen that these are largely inorganic. Under The Household Waste Management National Program (PNDM) (referred to as PNDM 2008-2023)[4] envisages to improve the waste collection rate in urban centers to 90% by year 2020 and 100% by year 2030. The current collection of waste is 82% in urban areas. It also aims at providing 350 urban centers with controlled for household and similar waste by year 2020. The study indicates that less than 1% waste is composted, 10% recycled (inorganic matter), 28% landfilled and remaining 62% is open dumped at a country level. It is expected, since the controlled landfills are located only near the urban centers (10 in total), the composting and open dumping is likely a phenomenon representing the fate of MSW in rural areas. Thus, the quantity of MSW at the controlled landfill sites near the urban center, e.g. Fes etc., is likely to be steady as there are no other MSW disposal methods practiced at a level that can be reported. The solid waste management is relatively developed[5] in areas like Fes due to private sector participation. Therefore, in Morocco, considering the current practices and governmental programs/policies in this direction, would continue to treat the organic matter/household waste in controlled manner using the controlled landfill sites even in the absence of the project activity.

[1] https://www.ustda.gov/news/successstories/MENAEE/MoroccoWastetoEnergySuccess.pdf

[2] Copy of contract was provided to the DOE (please refer page 10, second last paragraph)

[3] http://www.un.org/esa/dsd/susdevtopics/sdt_pdfs/meetings2010/icm0310/1c_Samir_Bensaid.pdf (see slide 14)

[4] http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportMorocco-En-mai2011.pdf

[5] http://ec.europa.eu/environment/enlarg/med/pdf/morocco_en.pdf (page 146 under MSW)

The methodology 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	The most plausible baseline scenario is status quo, which is the release of LFG into atmosphere
(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	The proposed CDM project activity will be connected to grid and supply the electricity to the same. In the absence of the project, an equivalent amount of electricity would have been produced in the power plants that are connected to grid.
(ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.	Not applicable.
This methodology 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;	No other methodology is applied therefore not relevant.
(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.	No management practice is envisioned to be changed and MSW would be dumped in the manner it is done since 2004. The landfill is already a managed landfill site as seen during validation site visit by the DOE.

Therefore, the baseline monitoring methodology that is most relevant to the project type and scale is **ACM0001** “**Flaring or use of landfill gas**” Version 13.0.0.
The project activity consists of capturing, its utilization in electricity generation in gas engines and flaring the gas when surplus is available.

B.3. Project boundary, sources and greenhouse gases (GHGs)

Landfill Gas is generated by the anaerobic decomposition of disposed solid waste. It is mainly composed of two Green House Gas (GHG), namely: Carbon Dioxide CO2) and Methane CH4.

	Source	GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the landfill site	CO_2	No	It is not considered because it is part of the natural carbon cycle.
		CH_4	Yes	Included as main component of LFG.
		N_2O	No	Not applicable
	Emission from electricity consumption	CO_2	No	Not applicable as no electricity is being consumed from the grid or being generated (On site/ Offsite)
		CH_4	No	Not applicable as above
		N_2O	No	Not applicable as above
	Emission from thermal energy generation	CO_2	No	No thermal energy is produced in the baseline therefore excluded.
		CH_4	No	Not applicable as above
		N_2O	No	Not applicable as above
Project scenario	On-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	There is no fossil fuel consumption expected, however included as a back up DG would be installed.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emissions from on-site electricity use	CO_2	Yes	There is power import so included
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

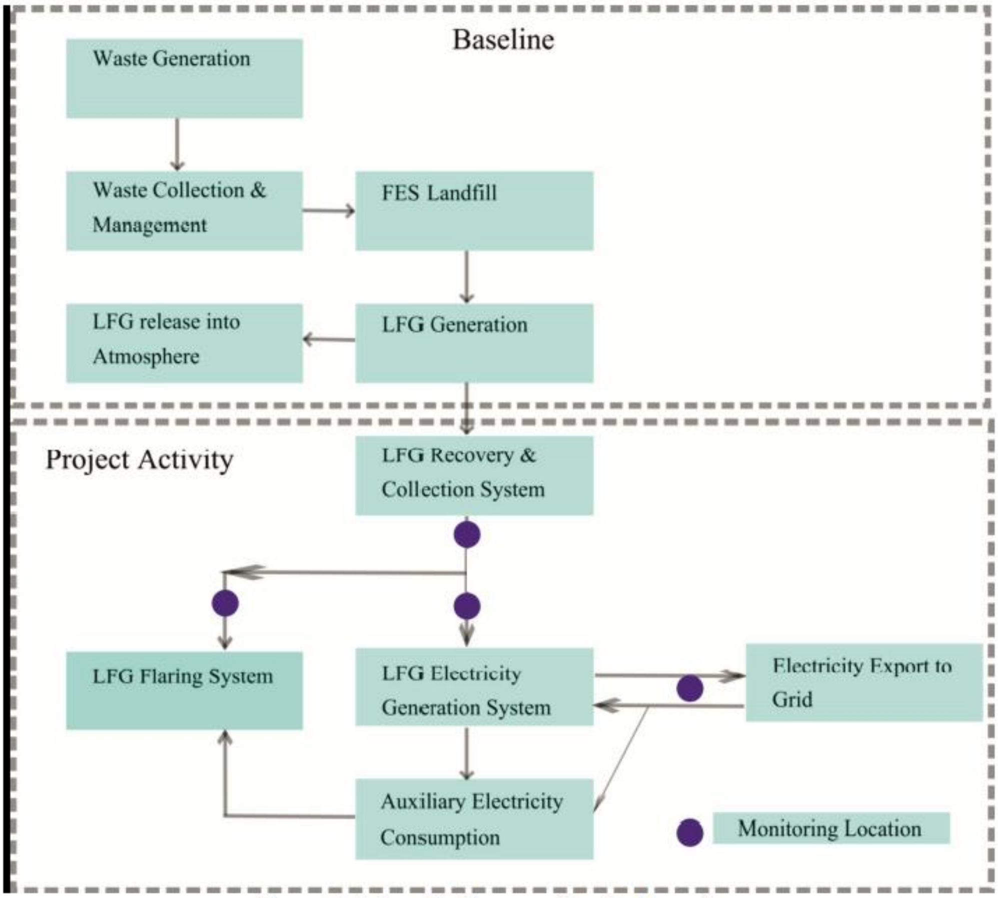


Figure 1: Schematic diagram of project boundary

Under the selected ACM0001 methodology, the estimation will not take into account the carbon dioxide generated by the anaerobic decomposition of solid waste disposed of at the landfill and released to the atmosphere, because it is part of the natural carbon balance. This also applies to the carbon dioxide resulting from the combustion of the generated methane. Although these two gas are not taken into account for the calculation of emission reductions, they are considered to be within the scope of the project, as they are involved as part of the managed landfill gas.
Although the carbon dioxide resulting from the generation of electricity used to supply the system will be negligible, as compared to the total reductions in tonnes of carbon that is expected to be achieved from the project, the value will be included in the project boundary and accounted in the related calculations.

B.4. Establishment and description of baseline scenario

ACM0001, Version 13.0.0, establishes procedures for the selection of the most plausible scenario using latest version of “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 05.0.0), which prescribes following steps;

STEP 0. Demonstration whether the proposed project activity is the First-of-its-kind
STEP 1. Identification of alternative scenarios;
STEP 2. Barrier analysis;
STEP 3. Investment analysis;
STEP 4. Common practice analysis.

STEP 0, STEP 1 and STEP 2 will be addressed in this section, while STEP 3 and STEP 4 will be addressed in Section B.5 as they pertain primarily to additionality.

STEP 0. Demonstration whether the proposed project activity is the First-of-its-kind
This step is optional. The step is not applied as it is not possible for project participants to confirm the same from publicly available documents and internet research. However, there is no contradictory information available in public domain in this regard.

STEP 1. Identification of alternative scenarios;
Sub-step 1a) Define alternative scenarios to the proposed CDM project activity
The project is located at a site where MSW is currently managed through the dumping in the managed landfill site and the emissions are therefore based on historical levels.

The LFG alternatives as prescribed in the ACM0001 Version 13.0.0 have been examined in the table below;

LFG alternatives prescribed in ACM0001	Justification
LFG1: The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);	The proposed project activity implemented without being CDM is economically not viable option as demonstrated in the section B.5. The alternative otherwise is plausible.
LFG2: Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, or to address safety and odour concerns;	The LFG generated at existing landfill site is managed but do not have any active gas collection system. The LFG to address the safety and odor concern is done via the pipeline that is connected to leachate treatment system in the baseline. The flaring in such system takes places on an average 10 days in a year to address the safety concern. However, the alternative is not plausible through out the year as there are no regulatory or contractual requirements to do so.
LFG3: LFG is partially not generated because	All the waste that landfill receives is dumped in

part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;	the landfill only and there is no other method at project site for waste treatment. The O&M contract with the municipality requires the project owner to manage the landfill only. Furthermore, the project site does not contain any other treatment methods for the waste received. In urban centers, like Fes, the MSW collection rates is 82%. In Morocco, almost 10% of MSW is recovered [6], which has been described inorganic recyclable component of the MSW, as explained earlier in Section B.2. Under The Household Waste Management National Program (PNDM) (referred to as PNDM 2008-2023 envisages to improve the waste collection rate in urban centers to 90% by year 2020 and 100% by year 2030. The current collection of waste is 82% in urban areas. It also aims at providing 350 urban centers with controlled for household and similar waste by year 2020[7]. Therefore, in Morocco, considering the current practices and governmental programs/policies in this direction, would continue to treat the organic matter/household waste in controlled manner using the controlled landfill sites. This is not plausible in the context of the project.
LFG4: LFG is partially not generated because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;	It has been reported that less than 1% waste is composted. It is expected, since the controlled landfills are located only near the urban centers (10 in total), the composting and open dumping is likely a phenomenon representing the fate of MSW in rural areas. Under The Household Waste Management National Program (PNDM) (referred to as PNDM 2008-2023 envisages to improve the waste collection rate in urban centers to 90% by year 2020 and 100% by year 2030. The current collection of waste is 82% in urban areas. It also aims at providing 350 urban centers with controlled for household and similar waste by year 2020. Therefore, in Morocco, considering the current practices and governmental programs/policies in this direction, would continue to treat the organic matter/household waste in controlled manner using the controlled landfill sites. All the waste that landfill receives is dumped in the landfill only and there is no other method at project site for waste treatment. The O&M contract with the municipality requires the project owner to manage the landfill only. Furthermore, the project site does not contain

[6] http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportMorocco-En-mai2011.pdf

[7] http://www.animaweb.org/uploads/E@C_Morocco_Urban%20services_FINAL.pdf (page 12)

	any other treatment methods for the waste received. This is not plausible in the context of the project.
LFG5: LFG is partially not generated because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.	The reasons mentioned for LFG3 and LFG4 are also the reason for LFG5. Further, in Morocco, medical and pharmaceutical waste is subject of incineration, which is not part of MSW. The other kind of waste, industrial waste, hazardous waste is also categorized separately and is not related with the MSW. This is though managed through storage/incineration and/or landfilling. There are separate ministries that deal with these types of waste[8]. Further[9], in Morocco, among the possible ways of treating the MSW includes less than 1% as compositing, 10% recycling, 28% landfilled and remaining 62% as open dumping. Therefore, this is not plausible in the context of the project.

Therefore, the plausible

- LFG1: Capture of landfill gas and its flaring and/or its use undertaken without being registered as a
  CDM project activity.
- LFG2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns. This scenario corresponds to the continuation of the current situation. Since there is currently no controlled capture and destruction of methane at the landfills, and no regulation will require such capture and destruction in the foreseeable future, the release of most of the landfill gas directly into the atmosphere would continue.

Furthermore, ACM0001 “Flaring or use of landfill gas” Version 13.0.0 states:
For electricity generation, alternative(s) shall include, *inter alia*:

Alternatives as per ACM0001 Version 13.0.0	Justification
E1: Electricity generation from LFG, undertaken without being registered as CDM project activity;	The proposed project activity implemented without being CDM is economically not a viable option as confirmed in the section B.5. The project participant has the choice to manage the landfill as per the existing contractual requirements without considering generating the electricity by any means. There is no mandatory or compulsory requirement to generate electricity for any use. The alternative otherwise is plausible.
E2: Electricity generation in existing or new renewable or fossil fuel based captive power plant(s);	There are no existing or new captive power plants at the project site neither there is need to generate electricity for any captive purposes. The power to run the landfill operations is drawn from the grid Therefore, the alternative is not plausible.
E3: Electricity generation in existing and/or	The electricity that is generated from the

[8] http://ec.europa.eu/environment/enlarg/med/pdf/morocco_en.pdf (page 146 under MSW)

[9] http://www.sweep-net.org/ckfinder/userfiles/files/country-profiles/CountryreportMorocco-En-mai2011.pdf (Chapter 2)

new grid-connected power plants.	project activity is fed to the national grid and therefore in the absence of project an equivalent amount of electricity would have been generated in the power plants that are connected to grid. Further, this alternative does not incur any cost for the PP. Therefore, the alternative is plausible.

Therefore, the only remaining options for plausible baselines for power generation are then:
E1: Electricity generation from LFG, undertaken without being registered as CDM project activity;
E3: Electricity generation in existing and/or new grid-connected power plants.

As for the heat generation, the proposed CDM project activity does not generate thermal energy for any purpose therefore the alternatives related to heat generation as described in the applied methodology are not discussed further.

Thus, the options listed above (LFG1, LFG2 and E1, E3) are the only realistic alternatives to be considered as possible alternative baselines. These alternatives will be considered below and further analyzed, in Section B.5.

Step 1b: Consistency with mandatory applicable laws and regulations
ACM0001 “Flaring or use of landfill gas” Version 13.0.0 states how national and sectoral policies must be taken into account using *Sub-step lb* of the Combined Tool and the adjustment factor AF Currently there are no legal and regulatory requirements in Morocco that would require capture or use of landfill gas. Therefore all possible scenarios described above would comply with national and local regulations.

The only document, regarding the management of solid waste in Morocco is the Law 28-00 which came in to effect on December 7, 2006. In the topic of landfill gas, this law does not address the landfill gas specifically, but a proposed decree to promulgate this law states only that gas must be managed in order to avoid risk of fire and presence of odors.

The Moroccan law does not require the installation of an active extraction system or flaring, and to the best knowledge of the author, no active extraction system has been installed in Morocco prior to the construction of Fes landfill”.

The Fes landfill, which opened in 2004, predating Law 28-00, envisioned at most the installation of a passive LFG venting system as a good practice. Therefore all alternatives as discussed above would comply with local regulations. The current configuration of the passive venting and limited burning, undertaken to meet safety requirements at Fes Landfill, may be characterized as follows:

- The landfill gas started to come out of the leachate collection pipes nearly after 6 months of the operation of the landfill began. As the leachate drains down gradient by gravity, the landfill gas goes upgradient inside the same pipes since they are not full. As a result, ECOMED installed a main pipe collector (connecting the top of the leachate laterals) to drain the gas from these pipe laterals into a single location. Hence, the LFG is only collected from the bottom of the landfill and is therefore considered deficient in this baseline scenario;
- The collected gas is directed to an open pipe for occasional burning whenever odour becomes a problem. However, this occasional burning is weak and most of the time the flame is out.

Technically this burning at the top of the vent pipe is considered to be negligible, comparing to the amount of gas currently vented from the top of the landfill. To be conservative, it was examined that the amount of gas that has been burnt at the existing passive system represents 3.28% based on the log book data of flare days vis-a-vis total days of the gas that would be collected by an active extraction system.

Based on the above, we can conclude that both LFG1 and LFG2 retained above, would comply with local regulations. The current situation at the Fes landfill corresponds to Alternative LFG2 and this situation meets all applicable legal requirements. Thus, the alternatives listed above (LFG1, LFG2 and E1, E3) are the only realistic alternatives to be considered as possible alternative baselines. These alternatives comply with the existing regulations.

STEP 2. Barrier analysis;
The alternatives identified above do not face any barrier other than what is presented in the investment analysis in section B.5.

Therefore, there are, the possible baseline scenarios are:

- Combination of LFG1+E1. The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity.
- Combination of LFG2+E3. Current situation at the Fes landfill.

An investment analysis for the combination of options LFG1+E1 is presented in section B.5. It is demonstrated that it is not an economically feasible option and therefore can be excluded from further consideration.

Therefore, the only remaining option is the combination of alternatives LFG2 + E3, which is the continuation of current practice that do not require any investment, and therefore the baseline scenario of the project activity.

B.5. Demonstration of additionality

A landfill gas capture and flaring system as foreseen by the project requires a large initial investment without any type of economic income during its operating phase. Approval and registration of the project within the Clean Development Mechanism (CDM), and the related certification and sale of the resulting emission reductions, will make it possible to obtain an economic reward that will facilitate the development and installation of the project for the benefit of its participants.

In order to demonstrate the additionality of the proposed project, the methodology recommended under ACM0001 / Version 13.0.0, and the latest version of “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 05.0.0). Step 0, 1 and 2 have been performed in the section B.4 already. The remaining steps i.e. Step 3 and Step 4 are included here below;

STEP 3: Investment analysis

The investment analysis determines whether the proposed project activity is not economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs).
The investment analysis is conducted according to the “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 05.0.0) and the “Guidelines on the Assessment of Investment Analysis” (version 05). Therefore, the following sub-steps shall be undertaken:

Determine appropriate analysis method

Alternative 1 (LFG2+E3), the status quo, do not have any cost or revenue, therefore, no investment analysis was performed for this alternative.

Alternative 2(LFG1+E1), landfill gas capture and flaring and utilization for electricity generation, involves substantial investment and revenues through the sale of electricity, in the absence of CDM. Hence, simple cost analysis cannot be applied. The investment comparison analysis is not used as the identified baseline scenario leaves project proponents to invest and not to invest. Therefore, the benchmark analysis (Option III) will be used for this alternative, which is appropriate in the context of the project activity.

Apply benchmark analysis:.

Identification of the financial indicator
The method of the Equity Internal Rate of Return (Equity IRR) was considered as the most appropriate, and the most suitable for the project type and decision context. Therefore, Equity IRR is the financial indicator based on which the project developer made the investment decision.

Identification of the benchmark The cost of equity (Ke) is selected as the benchmark in accordance to the "Guidelines on the Assessment of Investment Analysis" (Version 05),"Required/expected returns on equity are appropriate benchmarks for an equity IRR". For this purpose, the default values for the approximate expected return on equity for different project types and host countries as provided in the relevant guidance have been used.

As per the guidance, in situations where an investment analysis is carried out in nominal terms, project participants can convert the real term values provided in the table below to nominal values by adding the inflation rate. However, the investment analysis has been presented on real terms only therefore conservatively no inflation has been added to the benchmark. Therefore, the benchmark for post tax equity IRR (real cost of equity) has been considered 12% as prescribed in the EB62 Annex5 for the type of project in Morocco. Moreover, during the investment decision date Aug 4, 2006 same value was used by the project participants based on commercial expectations. Therefore, in the webhosted PDD a discount rate of 12% was used for determining project NPV. The considered benchmark is consistent with the assumption on the date of investment decision and start date as well and it is also conservative and default value prescribed in EB62 Annex5, as a cross check. Lastly, as per EB 73 Annex 8 para 4, the default returns on equity can also be applied by the projects having start date prior to EB 62.

Parameter	Value	Source
Cost of Equity (Real terms)	12%	Default value for cost of equity from EB 62, Annex 5
Inflation forecast	Nil	Not considered, conservative
Cost of Equity (Real Term)	12%	As per the investment guidelines

Establishment of the benchmark
Based on the previous analysis, the benchmark on real terms cost of equity is taken thus as 12 %, which is post tax.

Calculation and comparison of financial indicators:
The detailed financial analysis is provided in spreadsheet and also indicated below, where a full description of all the variables and assumptions. The "Guidelines on the Assessment of Investment Analysis" (version 05) was thoroughly observed in the elaboration of the financial analysis whose results are reported below, and the calculations given in the electronic spreadsheet"

Assumptions and calculation of the Equity IRR:

Capital Expenditures:
The project activity's main capital goods, include the gas collection pipes, the gensets, a flare and the gas blowers and pre-treatment systems. The project proponents have obtained quotes from vendors for all of these components during the feasibility study before the time of decision making i.e. Aug 4, 2006. The costs of each of these capital expenditures, the source of information, as well as the related documentations and revised details for Genset are presented in the table below.

Designation	**Total Cost MAD (DH)**	**Units**	**Source of information**	**Documentation**

Blowers and Gas Pretreatment	1,310,690	-	Quotation	Blowers and Gas Preatreat Quote from EII 2006
Flare	1,370,656	1	Quotation	Flare Quote from John Zinc 2006
Gensets	26,219,370	2	Quotation	1MW offer (euro) dated 15/01/2013
HDPE Pipes	1,620,288	-	Quotation	Pipes Quote from Plastima 2006
TOTAL	30,521,003			

The project cost usually have a contingency cost as 10%-20%, which was also assumed based on internal assessment, however, same has not been included in the project cost for lack of proper evidence. Therefore, in all it can be said the project cost considered here are on the conservative site and actual expenditure on the project is likely to exceed this quantity. Considering the financial indicator has been chosen as equity IRR therefore only equity portion out of the total capital expenditure has been considered in the calculation. The considered debt and equity ratio has been described in later sections of the PDD.

Operating Expenditures:
Operating expenditures such as O&M, insurance cost, and auxiliary consumption were obtained from vendors. Corporate tax rates were obtained from published literature. These costs, their sources and related documentation are presented in the table below.

Designation		**Source of information**	**Documentation**
Repairs and Maintenance cost	0.077 DH/kWh	Proposal from vendor	OPEX_Cost of O&M of Power Plant.pdf
Insurance Cost	Not applied	Proposal from provider	The insurance cost was assumed initially but has been now ignored as the data is not available. The impact of such exclusion is only conservative on equity IRR.
Overheads & Administration cost	1.00 Million DH	Estimated	Based on company rates
Corporate Tax Rate	35.00%	Published country tax rates	Official Bulletin No. 5382-bisArticle 20, Chapter III, page 990
Inflation rate	Not applied	NA	Inflation has not been considered. Conservative.
Auxiliary Consumption	3.00% of Gross	Manufacturer specification	CAPEX_Genset Quote from Kraft 2006

Designation	**Value**	**Source of information**	**Documentation**
Debt	50%	Default value	Annex 5, EB62
Equity	50%	Default value	Annex 5, EB62
Tenure	5 year	Proposal from the Bank	Rates and Loan Quotes from Bank 2006
moratorium	1 year	Proposal from the Bank	Rates and Loan Quotes from Bank 2006

<u>Electricity generation:</u>

The electricity production was calculated based on landfill gas generation and recovery simulations and summarized below. Please refer the corresponding IRR spreadsheet and CER spreadsheet for calculations.

Year	LFG generated (from CER sheet FOD Basics)	LFG captured (recovery rate)	Net Unit Generation	Transmission losses	Net quantity of electricity produced
	m3/h	60%	kW	3%	kWh
2013	2367	1,420	2,070	62	3,768,390
2014	2549	1,529	2,070	62	14,950,679
2015	2725	1,635	2,070	62	14,950,679
2016	2897	1,738	2,070	62	14,950,679
2017	3065	1,839	2,070	62	14,950,679
2018	3230	1,938	2,070	62	14,950,679
2019	3392	2,035	2,070	62	14,950,679
2020	3552	2,131	2,070	62	14,950,679
2021	3710	2,226	2,070	62	14,950,679
2022	3867	2,320	2,070	62	14,950,679
2023	4022	2,413	2,070	62	11,182,289

Electricity tariff:

The price of electricity considered in the analysis was obtained from the national grid. The terms are based on the standard power purchase conditions by the national grid as the sole mandated power purchaser in the country. The rate is calculated based on the national grid willingness to purchase power from independent producers at a rate equal to 50% of the rate the grid charges its customers during peak and full hours and at 40% of what it charges its customers at off-peak hours. The project participants had to negotiate at least on 3 occasions after the investment decision until 2009 even to get this assumption accepted, as highlighted in the section B.5 of the PDD. The source of information and documentation are provided in table below:

Designation	Value	Source of information	Documentation
Electricity Tariff	0.38 DH/kWh	national grid (ONE)	Energy Prices 2006

The value applied in the financial calculations reflects a flat rate of 0.38 based on the letter received from the national grid (ONE) that was valid and applicable at the time of investment decision. Unfortunately, the last communication that has been received from ONE in this regard that was provided to DOE reflects that the tariff is likely to be as under;

1-5 years: 0.45 DH/kWh
6-15 years: 0.37 DH/kWh

The basis of the calculation has been included as response to DOE's finding CAR#09 dated 19/06/2013. Therefore, the actual tariff that project activity is going to get is likely to differ slightly but is aptly covered under sensitivity analysis. Therefore, the applied tariff complies with para 6 of EB 62 Annex 5.

Results of the investment analysis:

The complete financial model and all underlying assumption are provided in the excel spreadsheet. Based on the assumptions provided above and in the financial model we conclude that the project activity has an equity IRR of 6.95% without considering the carbon revenues of the project. The comparison between this equity IRR and the benchmark calculated in sub-step_2b above, is presented below

Benchmark	12.0%
Project activity's Equity IRR without CDM revenues	6.95 %

The Table above clearly indicates that the return on equity of the project activity is below the sectoral benchmark without taking into account CDM revenues. This demonstrates that the proposed project activity is not a commercially attractive option without the support of CDM.

Sensitivity analysis

In the sensitivity analysis, the return on equity is subjected to sensitivities in key project assumptions. Following EB62 Annex 5 guidance, only those values that constitute for more than 20% of the total project costs or total project revenues should be subjected to a reasonable variation. Key assumptions that qualify for this are provided in table below and subjected to sensitivities of +/- 10%. The impact of the sensitivity analysis on the overall equity IRR of the project activity are presented in the same table.

Variable	**Sensitivity**			**Breaching Value**
	-10%	**0%**	**+10%**	**%**
Capital Cost	8.98%	6.95%	5.29%	-21.6%
Electricity Tariff	4.07%	6.95%	9.82%	17.6%
Electricity Generation	4.60%	6.95%	9.30%	21.5%
O&M Cost	7.48%	6.95%	6.42%	-97.5%
Efficiency of gas engine	6.41%	6.95%	7.24%	No such value
Benchmark	**12.0%**			

Based on the outcome of the sensitivity analysis we conclude that even after the sensitivity analysis the equity IRR for this project activity does not cross the benchmark.

Furthermore, following additional analysis was also undertaken and it is demonstrated that the equity IRR does not cross the benchmark if,
a) The equity portion is changed from 50% to any other % i.e., 10% - 100%
b) The availability of gas engines is increased from 85% to 100%
c) The auxiliary load of gas engines and transmission losses are ignored
d) The LFG recovery rate is increased from 60% to 100%
e) The salvage value is considered from 10% to 100%
f) The overheads and administrative cost considered 0
g) The gas engine efficiency is considered 100% in place of 38%.

Therefore, it is extremely unlikely that any of the key assumptions will exceed to the breaching value and therefore we conclude that the sensitivity analysis confirms that the project activity is financially unattractive without considering the benefits of CDM.

STEP 4: Common Practice Analysis
The common practice analysis is demonstrated using “Guidelines on common practice” Version 2.0 as prescribed.

Sub step 4a: The proposed CDM project activity(s) applies measure(s) that are listed in the definitions section above
1. **Applicable geographical area** should be the entire host country.
Therefore, entire country has been considered as applicable geographical area.

2. **Measure** (for emission reduction activities) is a broad class of greenhouse gas emission reduction activities possessing common features. Four types of measures are currently covered in the framework:
(a) Fuel and feedstock switch (example: switch from naphtha to natural gas for energy generation,

or switch from limestone to gypsum in cement clinker production);
(b) Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies (example: energy efficiency improvements, power generation based on renewable energy);
(c) Methane destruction (example: landfill gas flaring);
(d) Methane formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation).

The proposed CDM project activity is covered under point (b) and (c) above, therefore eligible. Considering the project activity will export power to the grid, which is why it is covered under point (b) and considering the project activity also involves flaring i.e., point (c) when surplus gas is available or gas engines are not able to use it, is also found applicable.

3. **Output** is goods/services produced by the project activity including, among other things, heat, steam, electricity, methane, and biogas unless otherwise specified in the applied methodology.
In the proposed CDM project activity the output is electricity generation using LFG.

4. **Different technologies** are technologies that deliver the same output and differ by at least one of the following (as appropriate in the context of the measure applied in the proposed clean development mechanism (CDM) project activity and applicable geographical area):
(a) Energy source/fuel (example: energy generation by different energy sources such as wind and hydro and different types of fuels such as biomass and natural gas);
(b) Feed stock (example: production of fuel ethanol from different feed stocks such as sugar cane and starch, production of cement with varying percentage of alternative fuels or less carbon intensive fuels);

(c) Size of installation (power capacity)/energy savings:
(i) Micro (as defined in paragraph 24 of decision 2/CMP.5 and paragraph 39 of decision 3/CMP.6);
(ii) Small (as defined in paragraph 28 of decision 1/CMP.2);
(iii) Large.

(d) Investment climate on the date of the investment decision, inter alia:
(i) Access to technology;
(ii) Subsidies or other financial flows;
(iii) Promotional policies;
(iv) Legal regulations;

(e) Other features, inter alia:
(i) Nature of the investment (example: unit cost of capacity or output2 is considered different if the costs differ by at least 20 %).

The technologies that use the same energy source/fuel (in this case LFG)_as the proposed CDM project activity, have been considered similar to the project activity while others are considered to be different. Therefore, power generation using LFG as a source has been considered similar to the project.

5. Step 1: calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity.
The designed capacity of the project activity is 2.134 MW therefore applicable output range considered is 1.067 MW to 3.2 MW.

6. Step 2: identify similar projects (both CDM and non-CDM) which fulfill all of the following conditions:
(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;

(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

Based on the conditions specified above, it can be confirmed that in the entire host country, the project applying the same measure (as specified above under Measure) that are using LFG as source to generate electricity and delivering comparable quality output (i.e. electricity) in the capacity 1.067 MW to 3.2 MW and that have started commercial operation prior to the start date date (as the publication of CDM PDD occurred at later date in the same year), there is not a single project that is similar to the project activity. To confirm this, the grid emission factor sheet that is provided to the DOE confirms that there are no LFG based power plants until year 2008, which is even after the project start date.

7. Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number *Nall.*

Therefore, the value of Nall in the case of proposed CDM project activity is '0'.

8. Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number *Ndiff*.
Considering the value of Nall itself is '0', there is no other plant that needs to be differentiated, therefore, Ndiff is also '0'.

9. Step 5: calculate factor F=1-*Ndiff*/*Nall* representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Therefore, considering both Ndiff and Nall are '0' the value of F is considered to be '0' as there is no technology that is similar to the project activity and has propagated in the host country as presented below;
F=1-Ndiff/Nall
Since Ndiff and Nall both are '0' the expression becomes
F=1-0/0

In mathematics, 0/0 is not a defined number and therefore it is meaningless number. However, taking note of the intent of the guidance give under Step 5 (as above) in this case it by showing the value of F as '0' what is implied that the penetration rate of the technology using the technology similar to the project activity is '0' as there is no other similar activity i.e. Nall itself is 0. Therefore, for the purpose of simplicity F is depicted as '0'. On the other hand, it would also not be correct to show the value of F as '1' considering 0/0 as '0'. This would have implied that technology has propagated already, which is not the case.

10. The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor *F* is greater than 0.2 and *Nall-Ndiff* is greater than 3.
As confirmed above that neither the value of F is greater than 0.2 nor Nall – Ndiff is greater than 3. Therefore, it can be summarized that the project is not a common practice and therefore additional.

PROJECT START DATE AND PRIOR CONSIDERATION OF CDM (EB62 ANNEX 13)
According to CDM Glossary of terms, "the start date shall be considered to be the earliest date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity". For The Fes New Landfill Gas Recovery, Reuse and

Flaring Project, the project activity started on January 24, 2008 when the project developer committed expenditures and purchased the blowers, flare and pre-treatment equipment for the biogas. However, the CDM was seriously considered way before the start date of project activity. Indeed, The Commune Urbaine de Fes (CUF) held a meeting on June 26, 2003 with the Ministry of Environment regarding the CDM for Fes Landfill. On November 2004, the CUF, based on an invitation from the Ministry of Environment, attended a workshop organized by the Ministry and UNDP for the development of CDM projects. On March 29, 2005, the Ministry of Environment offered assistance to the CUF for the development of a NIP for the project, and on May 11, 2005, the project was one of the nine projects for which the Ministry funded a NIP. This funding was intended for the development of the project for feasibility studies required, which is not the part of the project cost. Since, the NIP funding was secured only for the purpose of pre-feasibility studies, it is not considered in the investment analysis. Thereafter, in January 2006, the CUF asked Ecomed to conduct a feasibility study and economical analysis of the project and on July 5, 2006 asked the Ministry of Interior permission for an amendment to the landfill operation contract to explore the gas extraction and flaring within the framework of CDM. Ecomed submitted a PDD to the Moroccan DNA on February 3, 2008 and received an approval on June 13, 2008. The PDD for the project was webhosted from 19 August, 2008 to 17 September 2008. The letter of approval was later received again on 29 Dec 2009 during validation in favor of the
both the project participants.

In addition, the CUF and Ecomed started negotiations since 2006 with the national grid (ONE) for the sale of potential power that can be obtained from the landfill. Several meetings were held and correspondences exchanged (May 3, 2007 and October 20, 2007) between the parties. As can be seen from the above, the project participants have been for a long time aggressively pursuing the implementation of this project under CDM. The delays are mainly due to administrative procedures and power agreement negotiations.

Date	Event	Documentary Evidences
June 26, 2003	Meeting between Project Participant and Ministry of Environment	Letter from the CUF dated 26/06/2003
November 4, 2004	Project Participants attended workshop on CDM by the Ministry of Environment	Invitation Letter dated 04/11/2004
March 29, 2005	Offer by the Ministry of Environment to assist in the development of the project	Letter dated 29/03/2005
May 11, 2005	Funding of NIP by the Ministry of Environment	Letter dated 11/05/2005
January to March 2006	Performed FS and investment Analysis on the project	IRR Initial Investment Analysis
July 5, 2006	The CUF asked the Ministry of Interior for permission to pursue the project under CDM	Letter from the CUF to Ministry of Interior dated 05/07/2006
August 4, 2006	Approval of project by the Ministry of Interior	Signature of contract by the Ministry of the Interior date 04/08/2006 (investment decision)
May 3, 2007	Power agreement negotiations	Letter from CUF to ONE
October 20, 2007	Power agreement negotiations	Letter from CUF to ONE
January 24, 2008	Start date of CDM project activity	Purchase of Blowers and Flare, import documents
February 3, 2008	Submission of PDD and application to DNA	Letter of submittal dated 2/03/0208
June 13, 2008 and Dec 29, 2009	Approval by DNA	Letter of Approval dated 13/06/2008 and 29/12/2009 (in include both PP)
19 August to 17 September 2008	Webhosting of PDD	http://cdm.unfccc.int/Projects/Validation/DB/CSLYAOM7RGBONCZ903WL

		CO2YI01P95/view.html
April 16, 2009	Power agreement negotiations	Letter from project developer to ONE

As indicate above, the start date of the project activity is January 24, 2008 when the PP placed the purchased order towards the implementation of the project activity. As per EB62 Annex13 "GUIDELINES ON THE DEMONSTRATION AND ASSESSMENT OF PRIOR CONSIDERATION OF THE CDM" the project is an existing project activity as it started prior to 2 August 2008.

The awareness seriousness of the CDM is confirmed through the participation in the CDM workshop November 4, 2004 and other milestones indicated in the table. The parallel efforts to secure CDM benefits are confirmed by the approval (the initial one) that was secured on June 13, 2008 (i.e. with 6 months) and the publication of the PDD on UNFCCC on August 19, 2008. The project since then has been during validation stage.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

Baseline emissions:

The baseline emissions are to be calculated as per equation (1) of ACM0001 Version 13.0.0 as under;

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

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)

There is no natural gas component in the proposed CDM project activity therefore $BE_{NG,y}$ has been ignored as is not relevant. Further, as there is no heat generation component to the project activity therefore no baseline emissions are applicable for $BE_{HG,y}$.

Thus, in the case of project activity, the equation gets trimmed as under;

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

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

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

Where:

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

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

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s) as follows:

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

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)

$F_{CH4,EL,y}$, and $F_{CH4,flared,y}$ are determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” and monitoring the working hours of the power plant(s), boiler(s) so that no emission reduction are 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* ($Op_{j,h,y}$).

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.

Determination of $F_{CH4,EL,y}$, and $F_{CH4,flared,y}$ as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”

The project participants intend to monitor the mass flow of the LFG and the volumetric fraction of CH_4 in the LFG on a dry basis. Therefore, Option A of the tool shall be applied in the project activity. In addition, Option B of the tool shall be applied when it cannot be demonstrated that the LFG is measured dry, as per the requirements of the tool:

Option A
Option A is applicable where the volumetric flow of the LFG is measured on a dry basis. In order to demonstrate that the LFG gaseous stream is dry, the project participants will:

a) Not chosen by the project participant
b) Demonstrate that the temperature of the gaseous stream (Tt) is less than 60°C (331,15 K) at the flow measurement point.

If in a particular time interval it cannot be demonstrated that the gaseous stream is dry, then the flow measurement shall be assumed to be on a wet basis, and Option B shall be applied for the relevant time interval.

The mass flow of CH_4 shall be determined as follows:

$$F_{CH4,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t}$$

With

$$\rho_{CH4,t} = \frac{P_t * MM_{CH4}}{R_u * T_t}$$

Where:

$F_{CH4,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{CH4,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{CH4,t}$	=	Density of greenhouse gas *i* in the gaseous streamin time interval *t* (kg gas *i*/m^3gas*i*)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{CH4}	=	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* ($F_{CH4,t}$) is determined as defined under option A above. 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 as follows:

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

Where:

$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)

$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)

$v_{H2O,t,db}$= Volumetric fraction of H2O in the gaseous stream in time interval *t* on a dry basis (m^3 H2O/m^3 dry gas)

The volumetric fraction of H2O in time interval *t* on a dry basis (vH2O,t,db) is estimated according to following equation;

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

Where:

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

The absolute humidity of the gaseous stream (mH2O,t,db) is determined using Option 2 (Simplified calculation without measurement of the moisture content) as specified in the Determination of the absolute humidity of the gaseous stream section of the tool and the molecular mass of the gaseous stream ($MM_{t,db}$) is determined using following equation;

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

Where:

$m_{H2O,t,db,sat}$	=	Saturation absolute humidity in time interval *t* on a dry basis (kg H2O/kg dry gas)
$p_{H2O,t,Sat}$	=	Saturation pressure of H2O at temperature Tt in time interval t (Pa)

T_t = Temperature of the gaseous stream in time interval *t* (K)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O} = Molecular mass of H2O (kg H2O/kmol H2O)
$MM_{t,db}$ = Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Further, the molecular mass of the gaseous stream (MMt,db) is calculated as per following equation;

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

Where:
$MM_{t,db}$ = 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 H2O, contained in the gaseous stream (e.g. N2, CO2, O2, CO, H2,CH4, N2O, NO, NO2, SO2, SF6 and PFCs).

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.

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:

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

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)

$F_{CH4,sent\_flare,y}$ is determined directly using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, applying the requirements described above and as included in the section B.7.1 where the gaseous stream the tool is applied for the LFG delivery pipeline to the flare(s).

$PE_{flare,y}$ is be determined using the methodological tool “Tool to determine project emissions from flaring gases containing methane”. If LFG is flared through more than one flare, as is the case in the project activity as there is 1 open flare for back up purposes, which might be used in exigencies, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

Calculation for the emissions from the flare

Step 1: Determination of the methane mass flow rate in the residual gas

$F_{CH4,m}$ will be monitored through this approach, as under;

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

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*.

$F_{CH4,m}$, which is measured as the mass flow during minute *m*, shall then be used to determine the mass of methane in kilograms fed to the flare in minute *m* ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

As per the "Tool to determine mass flow of a greenhouse gas in a gaseous stream" the project participants should document in the PDD which option is applied. $F_{i,t}$ should be calculated following the steps/guidance described for each option.

Option Flow of gaseous stream Volumetric fraction

Option	Flow of Gaseous Stream	Volumetric Fraction
A	Volume flow – dry basis	Dry or wet basis
B	Volume flow – wet basis	Dry basis
C	Volume flow – wet basis	Wet basis
D	Mass flow – dry basis	Dry or wet basis
E	Mass flow – wet basis	Dry basis
F	Mass flow – wet basis	Wet basis

The project activity has selected Option A according to the above table, based on the idea that the gas stream will be demonstrated to be dry else and Option B shall be applied for the relevant time interval.

Step 2: Determination of flare efficiency

The project activity uses the enclosed flare as part of the proposed project activity however a backup open flare would also be used. Therefore, following methods will be applied to calculate emissions accordingly, as appropriate;

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* (Flamem), 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.

The PP will use Option A, as under;

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. Therefore, the adjusted value applied will be 80% for flare efficiency.

The design specification provided by the Flare Manufacturer are as under;
Flare dimensions: W*L*H = 2229 * 8298 * 7434 (in mm)
Stack height: Effective as 6630 mm and 8805 mm as Total.

The effective height of the stack has been given by the manufacturer as 6630 mm considering a portion of the flare would be utilized to house the 9 burners. The Width (synonymous with diameter in this case) has been prescribed as 2229 (in mm), therefore the height of the flare is approximately 3 times to that of its diameter. Therefore, the flare that is installed in the project activity is a low enclosed flare as per the methodological tools ‘Project emissions from flaring’ Version 2.0.0

Option A: Default value

The flare efficiency for the minute *m* ($\eta_{flare,m}$) is 80% (after adjustment as required by the tool ‘Project emissions from flaring’ Version 2.0.0) 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%.

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 (FCH4,RG,m) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \times \left(1-\eta_{flare,m}\right) \times 10^{-3}$$

Where:

$PE_{flare,y}$	=	Project emissions from flaring of the residual gas in year *y* (tCO2e)
GWP_{CH4}	=	Global warming potential of methane valid for the commitment period (tCO2e/tCH4)
$F_{CH4,RG,m}$	=	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	=	Flare efficiency in minute m

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 in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$$

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 amount of methane generated from disposal of waste at the SWDS is calculated based on a first order decay (FOD) model.1 The model differentiates between the different types of waste *j* with respective constant decay rates (*kj*) and fractions of degradable organic carbon (*DOCj*). The model calculates the methane generation occurring in year *y* (a period of 12 consecutive months) or month *m* based on the waste streams of waste types *j* (*Wj,x* or *Wj,i*) disposed in the SWDS over a specified time period (years or months).

In cases where at the SWDS methane is captured (e.g. due to safety regulations) and flared, combusted or used in another manner that prevents emissions of methane to the atmosphere, the emissions are adjusted for the fraction of methane captured (fy).

The amount of methane generated from disposal of waste at the SWDS is calculated for year *y* (BECH4,SWDS,y) using equation (1) of the methodological tool 'Emissions from the solid waste disposal sites' Version 06.0.1 as prescribed by the ACM0001 Version 13.0.0

The basis selected in the proposed CDM project activity is yearly. The specific time period (the consecutive years *x* or months *i*) in which waste disposal is considered in the calculation is from year 2004, for application A, that starts when the SWDS starts receiving waste.

Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS.
Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. ACM0001). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an *ex-ante* estimation of emissions in the CDM-PDD. The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS).

The emissions are calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1 - f_y) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum W_{jx} \cdot DOC_j \cdot e^{-kj(y-x)} \cdot (1 - e^{-kj})$$

Where, for the yearly model:
$BE_{CH4,SWDS,y}$= Baseline, project or leakage methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (t CO2e / yr)

x = Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*).
y = Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$W_{j,x}$ = Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t)

And, where for both the yearly and monthly models:
φy = Model correction factor to account for model uncertainties for year *y*

fy = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
GWP_{CH4} = Global Warming Potential of methane
OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)

F = Fraction of methane in the SWDS gas (volume fraction)
MCFy = Methane correction factor for year *y*
DOCj = Fraction of degradable organic carbon in the waste type *j* (weight fraction)
kj = Decay rate for the waste type *j* (1 / yr)
j = Type of residual waste or types of waste in the MSW

Determining the parameters required to apply the FOD model
Table below summarizes how the parameters required in this tool can be determined. This includes the use of default values, one time measurements or monitoring throughout the crediting period. The selection of the option that can be used depends on whether the tool is used for application A or B.

Table: Overview of the option to determine parameters for application A

Parameter	Application A
Φ	Default value as per methodological tool 'Emissions from solid waste disposal sites' Version 06.0.1
OX	Default value
F	Default value
DOC_{fy}	Default value
MCFy	Default value, based on SWDS type
k_j	Default value
$W_{j,x}$	Estimated once
DOC_j	Default value
f_y	Estimated once

Determining the model correction factor (φy)

The model correction factor (φh) depends on the uncertainty of the parameters used in the FOD model. If project or leakage emissions are being calculated, then φy = φdefault = 1. If baseline emissions are being calculated, then project participants may choose between the following two options to calculate φy:

Option 1: Use a default value

Use a default value: φs= φdefault.

Default values for application A is prescribed as 0.75, which has been considered in case of project activity. Though, there is no difference between dry or wet/humid for this type of application. Option 1 has been selected by the PP, as per the choice given in the referred tool therefore, Option 2 is not discussed further.

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

Where *different* waste types *j* are disposed or prevented from disposal in the SWDS (for example, in the case of MSW), it is necessary to determine the amount of different waste types (Wj,x orWj,i). In the case that only one type of waste is disposed (for example, in the case of a residual waste), then Wj,x = Wx and Wj,i = Wi and the following procedures do not need to be applied (e.g. waste sampling is not required). The requirements pertaining to application A are only discussed here, as relevant to proposed CDM project activity.

Application A

Calculation of Wj,x is based on information from the public bid for SWDS management from administration. This is in line to the information given in the tool i.e., further historic information on amounts, composition and origin of the waste might be found in SWDS administration documents (e.g. contracts with clients and invoices to clients) or obtained from old business plans or business evaluations.

WASTE COMPOSITION & DEGRADABLE ORGANIC CONTENT – DOCj	Food	Paper Cardboard	Wood	Textile	Garden waste	Plastic, metal glass, other inert
Waste composition ($W_{j,x}$)	**50.3%**	**7.4%**	**0.0%**	**5.7%**	**7.8%**	**28.8%**

Determining the fraction of DOC that decomposes in the SWDS (DOCf,y)

Application A

DOCf,y is considered as a default value ($DOC_{f,y} = DOC_{f,default}$) provided in the tool 'Emission from solid waste disposal sites' page 11.

WASTE COMPOSITION & DEGRADABLE ORGANIC CONTENT – DOCj	Food	Paper Cardboard	Wood	Textile	Garden waste	Plastic, metal glass, other inert
Fraction of degradable organic content in the waste type j – DOCj	**15%**	**40%**	**43%**	**24%**	**20%**	**0%**

Procedure to determine the methane correction factor (MCFy)

Application A

The MCF is selected as a default value ($MCF_y = MCF_{default}$) provided in the tool as per the state of landfill site. The existing SWDS is anaerobic managed solid waste disposal site, where there is controlled placement of waste (i.e. waste is directed to specific cell open at that point of time, a degree of control of scavenging and degree of control of fires too). The waste directed to cells is leveled using earth movers, compacted to reduce the volume and then finally covered with soil. Therefore, in the context of the project activity MCFy is considered to 1.0.

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 below are distinguished as per methodology ACM0001 Version 13.0.0

Table: 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:

$$F_{CH4,BL,y} = 0$$

Though, there is no requirement to destroy methane getting generated from landfill site either in the existing contract, provided to the DOE, or in the law. However, in order to address the local safety and fire hazards, it was noted based on the plant records of the landfill management that approximately for 10 random days in a year the LFG is allowed to burnt through extended pipes. There also exists a rather rudimentary LFG capture system, which are simply the vertical pipes that allow easy passage for LFG to get liberated into atmosphere and reduces pressure beneath the cell. Therefore, Case 1 is not exactly applicable in the context of the project activity.

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

This case has not been pursued further as there is no requirement to destroy methane in the host country, as provided to the validating DOE and as explained under Case 1, above.

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

In this situation:

$$F_{CH4,BL,y} = F_{CH4,BL,sys,y}$$

- *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 $F_{CH4,BL,sys,y}$ is determined as follows:*

$$F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y}$$

Where:

$F_{CH4,BL,sys,y}$	=	*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)*
$F_{CH4,sent\_flare,y}$	=	*Amount of methane in the LFG which is sent to the flare in year y (t CH_4/yr)*

$F_{CH4,sent\_flare,y}$ 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 stream the tool shall be applied to is the pipeline collecting LFG from the existing LFG capture system.

As there is neither any requirement to destroy methane nor there is any incentive to monitor the LFG coming out of it, there is no practice of monitoring the same. Furthermore, there is no flare installed at project site in the absence of the project activity the occasional burning of LFG takes place only randomly 10 times in a year and through the extended pipes only to address the safety concern. Therefore this situation is not relevant and possible in case of the project activity.

- *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:*

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y}$$

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:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y}$$

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.

As explained earlier that there is no monitored data available for methane that is destroyed in the absence of the project activity other than that it occurred on 10 random days in a year on an average based on plant records. Therefore, this approach is not suitable in the proposed CDM 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:

$$F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y}$$

The project participant chooses to apply this though the plant records suggest that the actual combustion in extended pipes was only 3.28% based on the monitored data. Therefore Case 3 and the choice prescribed above is appropriate for the project activity as 20% is far more conservative than 3.28% in reality.

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

As explained above, considering there is no requirement for destruction of methane therefore this Case has not been pursued further.

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

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) are 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* ($EG_{PJ,y}$).

As demonstrated in Section B.4, the most plausible baseline for the net electricity that is generated from the project activity is its generation in the existing and/or new grid connected power plants.

Therefore, as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" , which is prescribed for Scenario A. The Scenario A is relevant in case of project activity as the power generated from the project activity after taking care of on site consumption would be fed to national grid. There is a back up DG for exigencies, which is not connected to grid.

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

Where:

$BE_{EC,y}$	=	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*
k	=	Sources of electricity consumption in the baseline

Determination of the emission factor for electricity generation ($EF_{EL,k,y}$**)**

The determination of the emission factors for electricity generation ($EF_{EL,k,y}$) depends on which scenario (A, B or C) applies to the source of electricity consumption. Since, the project is qualified for Scenario A the approach prescribed for the same are discussed below;

Scenario A: Electricity consumption from the grid

In this case, project participants may choose among the following options:

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the .Tool to calculate the emission factor for an electricity system. ($EF_{ELk,y} = EF_{grid,CM,y}$).

Option A2: Use the following conservative default values:

- A value of 1.3 tCO_2/MWh if

  (a) Scenario A applies only to project and/or leakage electricity consumption sources but not to baseline electricity consumption sources; or
  (b) Scenario A applies to: both baseline and project (and/or leakage) electricity consumption sources; and the electricity consumption of the project and leakage sources is greater than the electricity consumption of the baseline sources.

- A value of 0.4 tCO_2/MWh for electricity grids where hydro power plants 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, and a value of 0.25 tCO_2/MWh for other electricity grids. These values can be used if

  (a) Scenario A applies only to baseline electricity consumption sources but not to project or leakage electricity consumption sources ; or
  (b) Scenario A applies to: both baseline and project (and/or leakage) electricity consumption sources; and the electricity consumption of the baseline sources is greater than the electricity consumption of the project and leakage sources.

The project participant has selected Option A2 and considered the default values of 0.4 tCO2e/MWh as indicated in section B.6.2 $EF_{EL,k,y}$

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

Step C is not applied as the proposed CDM project activity is not having any heat generation component.

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

As per ACM0001 Version 13.0.0, $BE_{NG,y}$ is estimated as follows:

$$BE_{NG,y} = 0.0504 \times F_{CH4,NG,y} \times EF_{CO2,NG,y}$$

Where:

$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2e/yr)
$EF_{CO2,NG,y}$	=	Average CO_2 emission factor of natural gas in the natural gas network in year *y* (t CO_2e / TJ)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (t CH_4 /yr)

$EF_{CO2,NG,y}$ is determined using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

However, Step D is not being applied here as these are not relevant in case of project activity and there is no natural gas system that is being displaced at the project site.

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y}$$

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". 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.

However, as explained earlier, the combustion in the baseline occurred through the extended pipes and did not require any electricity. Therefore this approach is not relevant in case of the project activity.

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". 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.

Leakage

No leakage effects are accounted for under this methodology.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

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)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	OX_{top_layer}
Data 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	Default value for application A as per the tool Emissions from SWDS
Purpose of data	Baseline calculations
Additional comment	NA

Data/Parameter	$F_{CH4,BL,x-1}$
Data unit	t CH4/yr
Description	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity
Source of data	Default value as per ACM0001 Version 13.0.0
Value(s) applied	20%
Choice of data or measurement methods and procedures	The value is prescribed for Case 3 of Step A.2 of ACM0001 Version 13.0.0.
Purpose of data	Baseline emissions
Additional comment	This term is synonymous to $F_{CH4,BL,sys,y}$

Data/Parameter	GWP_{CH4}
Data unit	tCO2e/tCH4
Description	Global warming potential of methane valid for the commitment period
Source of data	IPCC
Value(s) applied	25 Shall be updated for future commitment periods according to any future COP/MOP decisions
Choice of data or measurement methods and procedures	Default value prescribed by IPCC for 2nd commitment period.
Purpose of data	Baseline emissions
Additional comment	The value has changed from 21 to 25, as per IPCC for 2nd commitment period.

Data/Parameter	η_{PJ}
Data unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project Activity
Source of data	Estimated
Value(s) applied	60%
Choice of data or measurement methods and procedures	The expected efficiency of the LFG capture system is likely not to exceed 60% based on the experience. The assumption at the time of investment decision was 60% and therefore same has been used in contrast to 50% prescribed as default by ACM0001 V13.0.0
Purpose of data	Baseline emissions
Additional comment	The value is conservative from additionality perspective and is used only for the purpose of ex ante estimation of CERs.

Data/Parameter	$\varphi_{default}$
Data unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	Methodological Tool “Emissions from solid waste disposal sites”
Value(s) applied	0.75 for baseline emissions 1.00 for project or leakage emissions, if any
Choice of data or measurement methods and procedures	The applied value has been chosen considering the application A, which is project activity and dry conditions. Though, there is no difference in the value when humid or wet is chosen.
Purpose of data	Baseline emissions
Additional comment	NA

Data/Parameter	OX
Data 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	Methodological Tool “Emissions from solid waste disposal sites”
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value as per Methodological Tool “Emissions from solid waste disposal sites”
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	Default value as per Methodological Tool “Emissions from solid waste disposal sites”
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$DOC_{f,default}$
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	The value is prescribed for application A, which is project activity, as per Methodological Tool “Emissions from solid waste disposal sites”
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$MCF_{default}$
Data unit	NA
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0 for anaerobic managed solid waste disposal sites
Choice of data or measurement methods and procedures	There is controlled placement of waste (i.e.waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and includes the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste;
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	DOC_j
Data unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	Data from public bid for the SWDS
Value(s) applied	see table below
Choice of data or measurement methods and procedures	The data has been used on wet basis, as provided by the municipality during public bid for SWDS.
Purpose of data	Baseline emissions
Additional comment	-

Value(s) applied:

Food	Paper Cardboard	Wood	Textile	Garden waste	Plastic, metal glass, other inert
50.3%	**7.4%**	**0.0%**	**5.7%**	**7.8%**	**28.8%**

Data/Parameter	**k_j**
Data unit	1/yr
Description	Decay rate for the waste type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	Food: **0.185**; Paper Cardboard: **0.060**; Wood: **0.030**; Textile: **0.060**; Garden waste: **0.100**
Choice of data or measurement methods and procedures	MAT Mean Average Temperature (www.worldclimate.com): 17.2 MAP Mean Average Precipitation (www.worldclimate.com): 546 MAP/PET = aridity index: 3 Therefore, values are selected for wet boreal or temperate climate
Purpose of data	Baseline emissions
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>$EF_{EL,k,y}$</td></tr>
<tr><td>Data unit</td><td>tCO2e/MWh</td></tr>
<tr><td>Description</td><td>CO2 emissions intensity of the baseline source of electricity displaced, which in this case corresponds to electricity provided from the ONE grid connected to the project site, tCO2e/MWh.</td></tr>
<tr><td>Source of data</td><td>Tool to calculate baseline, project and/or leakage emissions from electricity consumption Version 1</td></tr>
<tr><td>Value(s) applied</td><td>0.4 tCO2e/MWh</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>
The values will be applied conservatively taking note of the prescription in the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” Version 1, as under;
A value of 0.4 tCO_2/MWh for electricity grids where hydro power plants constitute less than 50% of total grid generation in 1) average of the five most recent years,
The average value of 5 most recent years indicates that hydro power plant contributed less than 10% of the total electricity production in grid, as under (source specified below);
<table>
<tr><td></td><td colspan="2">Power generation (GWh)</td><td>Average share of Hydro</td></tr>
<tr><td>Year</td><td>Hydro</td><td>Total</td><td>%</td></tr>
<tr><td>2012</td><td>1631</td><td>26495.5</td><td>6.15</td></tr>
<tr><td>2011</td><td>2005.3</td><td>24363.6</td><td>8.23</td></tr>
<tr><td>2010</td><td>3467.8</td><td>22851.4</td><td>15.17</td></tr>
<tr><td>2009</td><td>2568.5</td><td>20809.2</td><td>12.34</td></tr>
<tr><td>2008</td><td>916.2</td><td>20306.8</td><td>4.51</td></tr>
<tr><td>Total</td><td>10588.8</td><td>114826.5</td><td>9.22</td></tr>
<tr><td colspan="3">Average over 5 years:</td><td>9.28</td></tr>
</table>
This value can be used if
(b) Scenario A applies to: both baseline and project (and/or leakage) electricity consumption sources; <u>and</u> the electricity consumption of the baseline sources is <u>greater</u> than the electricity consumption of the project and leakage sources.
</td></tr>
<tr><td>Purpose of data</td><td>Baseline and project emissions</td></tr>
<tr><td>Additional comment</td><td>A single, fixed value is used for entire crediting period.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$SPEC_{flare}$</td></tr>
<tr><td>Data unit</td><td>Temperature - °C
Flow rate or heat flux - kg/h or Nm3/h
Maintenance schedule - number of days</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule</td></tr>
<tr><td>Source of data</td><td>Flare manufacturer</td></tr>
<tr><td>Value(s) applied</td><td>Minimum - Maximum flow rate = 500 Nm3/h to 2000 Nm3/h)
Minimum – Maximum operating temperature = 1000 °C to 1150 °C)
Maintenance schedule – Not available/specified</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>The flare specifications set by the manufacturer for the correct operation of the flare as specified above.</td></tr>
<tr><td>Purpose of data</td><td>Project emissions</td></tr>
<tr><td>Additional comment</td><td>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</td></tr>
</table>

Data/Parameter	η_{flare}
Data unit	-
Description	Flare efficiency in minute m
Source of data	Methodological Tool 'Project emission from flaring' Version 2.0.0
Value(s) applied	80%
Choice of data or measurement methods and procedures	Default value for low height enclosed flares in accordance with Tool 'Project emission from flaring' is 90%, however same has been adjusted by subtracting 0.1 from the default efficiency as a conservative approach prescribed in the referred Tool.
Purpose of data	Project emissions
Additional comment	-

Parameters and data that are not monitored include the constants used in equations, as listed below;

Table 2: Constants used in equations Parameter	**SI Unit**	**Description**	**Value**
MMCH4	kg/kmol	Molecular mass of methane	16.04
MMCO	kg/kmol	Molecular mass of carbon monoxide	28.01
MMCO2	kg/kmol	Molecular mass of carbon dioxide	44.01
MMO2	kg/kmol	Molecular mass of oxygen	32.00
MMH2	kg/kmol	Molecular mass of hydrogen	2.02
MMN2	kg/kmol	Molecular mass of nitrogen	28.02
AMC	kg/kmol (g/mol)	Atomic mass of carbon	12.00
AMH	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AMO	kg/kmol (g/mol)	Atomic mass of oxygen	16.00
AMN	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
Pref	Pa	Atmospheric pressure at reference conditions	101 325
Ru	Pa.m3/kmol.K	Universal ideal gas constant	0.008314472
Tref	K	Temperature at reference conditions	273.15
vO2,air	Dimensionless	O2 volumetric fraction of air	0.21
MVn	m3/Kmol	Volume of one mole of any ideal gas at reference conditions	22.414
ρ CH4, n	kg/m3	Density of methane gas at reference conditions	0.716
NAi,j	Dimensionless	Number of atoms of element j in component i, depending on molecular structure	
VMref	m3 / kmol	Volume of one mole of any ideal gas at reference temperature and pressure	22.4

B.6.3. Ex ante calculation of emission reductions

Baseline Emissions

As explained in the section B.6.1 the trimmed equation for the proposed CDM project activity is;

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

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)

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

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

Where:

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

The detailed calculations have been performed in the corresponding CER spreadsheet and the results are summarized below;

Year	$BE_{CH4,SWDS,y} = \varphi\ (1\text{-}f) * GWP_{CH4} * (1\text{-}OX) * 16/12 * F * DOC_f * MCF * \Sigma\Sigma\ w_{j,x} * DOC_j * e^{-kj(y-x)} * (1\text{-}e^{-kj})$
2013	46,831
2014	200,064
2015	213,908
2016	227,398
2017	240,590
2018	253,531
2019	266,261
2020	278,814
2021	291,216
2022	303,493
2023	236,098
Total	**2,558,203**

The emissions in the year 2013 corresponds to the period from 01/10/2013 (credit period start date) to 31/12/2013 and likewise in the year 2023 upto 30/09/2023 (end of crediting period).

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) as follows:

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

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)

This quantity is not yet available and would be monitored during the crediting period.

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:

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$$

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)

Year	$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$
2013	1,124
2014	4,802
2015	5,134
2016	5,458
2017	5,774
2018	6,085
2019	6,390
2020	6,692
2021	6,989
2022	7,284
2023	5,666
Total	**61,397**

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

Situation at the start of the project activity	**Requirement to destroy Methane**	**Existing LFG capture and destruction system**
Case 3	No	Yes

As prescribed in the ACM0001 Version 13.0.0 and as explained under section B.6.1 following methodology is applied;

- 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:

$$F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y}$$

The project participant choose to apply this though the plant records suggest that the actual combustion in extended pipes was only 3.28% based on the monitored data. Therefore Case 3 and the choice prescribed above is appropriate for the project activity as 20% is far more conservative than 3.28% in reality.
Therefore, the values obtained were as under;

Year	$F_{CH4,BL,y} = F_{CH4,BL,sys,y} = 0.2 * F_{CH4,PJ,y}$
2013	225
2014	960
2015	1,027
2016	1,092
2017	1,155
2018	1,217
2019	1,278
2020	1,338
2021	1,398
2022	1,457

2023	1,133
Total	**12,279**

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

The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) are 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* ($EG_{PJ,y}$).

As demonstrated in Section B.4, the most plausible baseline for the net electricity that is generated from the project activity is its generation in the existing and/or new grid connected power plants.

Therefore, as per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" , which is prescribed for Scenario A. The Scenario A is relevant in case of project activity as the power generated from the project activity after taking care of on site consumption would be fed to national grid. There is a back up DG for exigencies, which is not connected to grid.

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

Where:

$BE_{EC,y}$	=	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*
k	=	Sources of electricity consumption in the baseline

Determination of the emission factor for electricity generation ($EF_{EL,k,y}$)

The project participant has selected Option A2 and considered the default values as indicated in section B.6.2 $EF_{EL,k,y}$

The final results of the calculations are presented below;

Year	Estimation of EL_{LFG} (MWh) Net	Baseline emissions (tCO_2e)
		$BE_y = EF_{EL,k,y} * EL_{LFG,y}$
2013	3,768	1,507
2014	14,951	5,980
2015	14,951	5,980
2016	14,951	5,980
2017	14,951	5,980
2018	14,951	5,980
2019	14,951	5,980
2020	14,951	5,980
2021	14,951	5,980
2022	14,951	5,980
2023	11,182	4,473
Total	**149,507**	**59,803**

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

As discussed under section B.6.1, the Step C is not applied here as there is not heat generation component in the proposed CDM project activity.

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

As discussed under section B.6.1, the Step D is not being applied here as these are not relevant in case of project activity and there is no natural gas system that is being displaced at the project site.

Project emissions:

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y}$$

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 ($PE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". 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.

However, as explained earlier, the combustion in the baseline occurred through the extended pipes and did not require any electricity. Therefore this approach is not relevant in case of the project activity.

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". 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.

No project emissions are expected from the project activity. However, any energy consumption that is utilized from grid, in the event gas engines are not working and flares need to run, same will be accounted as all import from the grid is included as monitored parameter. The captive DG set is kept for the project activity and will be monitored for the project emissions as per the tool. However, it is not envisaged at the moment as power can be drawn from the grid, which will be already recorded, as indicated above.

Leakage:

No leakage effects are accounted for under this methodology.

Emission reductions:

An excel calculation spreadsheet is given with this document explaining in detail the calculation of the ex-ante emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(1)}$$

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.

If the energy component is intended to be implemented after the first year of the project activity, then project participants may exclude the energy component from the ex-ante estimation of baseline emissions. This avoids overestimating ex ante estimate of emissions if energy generation is not implemented, or a lower capacity is implemented than originally envisaged. This exclusion is not applicable to the determination of the baseline or demonstration of additionality.

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

Table-1: Ex-ante estimation of emission reductions from methane avoidance/destruction

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2013*	20,231	0	0	20,231
2014	86,428	0	0	86,428
2015	92,408	0	0	92,408
2016	98,236	0	0	98,236
2017	103,935	0	0	103,935
2018	109,525	0	0	109,525
2019	115,025	0	0	115,025
2020	120,447	0	0	120,447
2021	125,805	0	0	125,805
2022	131,109	0	0	131,109
2023	101,994	0	0	101,994
Total	**1,105,144**	0	0	**1,105,144**
Total number of crediting years	10			
Annual average over the crediting period	**110,514**	0	0	**110,514**

Table-2: Ex-ante estimation of emission reductions from electricity displacement to grid

Year	Baseline emissions ($t CO_2e$)	Project emissions ($t CO_2e$)	Leakage ($t CO_2e$)	Emission reductions ($t CO_2e$)
2013	1,507	0	0	1,507
2014	5,980	0	0	5,980
2015	5,980	0	0	5,980
2016	5,980	0	0	5,980
2017	5,980	0	0	5,980
2018	5,980	0	0	5,980
2019	5,980	0	0	5,980
2020	5,980	0	0	5,980
2021	5,980	0	0	5,980
2022	5,980	0	0	5,980
2023	4,473	0	0	4,473
Total	**59,803**	**0**	**0**	**59,803**
Total number of crediting years	10			
Annual average over the crediting period	**5,980**	**0**	**0**	**5,980**

Table-3: Total ex-ante estimation of emission reductions from methane avoidance/destruction and electricity displacement

Year	Baseline emissions ($t CO_2e$)	Project emissions ($t CO_2e$)	Leakage ($t CO_2e$)	Emission reductions ($t CO_2e$)
2013	21,738	0	0	21,738
2014	92,408	0	0	92,408
2015	98,389	0	0	98,389
2016	104,216	0	0	104,216
2017	109,915	0	0	109,915
2018	115,506	0	0	115,506
2019	121,005	0	0	121,005
2020	126,428	0	0	126,428
2021	131,786	0	0	131,786
2022	137,089	0	0	137,089
2023	106,467	0	0	106,467
Total	**1,164,946**	**0**	**0**	**1,164,946**
Total number of crediting years	10			
Annual average over the crediting period	**116,494**	**0**	**0**	**116,494**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$V_{t,db}$ / $V_{t,wb}$ / $FVR_{G,h}$ ($F_{CH4,EL,y}$)
Data unit	Nm³ /h
Description	For: $V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis; $V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis; $FVR_{G,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Source of data	Measurements by Project participants using a flow meter
Value(s) applied	Not available
Measurement methods and procedures	Shall be monitored for the LFG gaseous stream delivered for electricity generation in the gas engines. The instruments with recordable electronic signal (analogical or digital) shall be installed. This parameter shall be continuously monitored by flow meters. The accuracy of monitoring equipment is according to national standard. Regarding parameters $V_{t,db}$ and $V_{t,wb}$, the volumetric flow rate of the residual gas at normal conditions in the hour h will be measured according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the measurement option in the project activity will be: Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; Option (B) wet basis: when the temperature of gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point; Regarding parameter $FVR_{G,h}$, Project Participant will ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 ºC.
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment will be in accordance with manufacturer’s specifications.
Purpose of data	Baseline emissions
Additional comment	NA

Data/Parameter	Vt,db / Vt,wb / FVRG,h (FCH4,sent_flare,y)
Data unit	Nm³ /h
Description	For: $V_{t,db}$ = Volumetric flow of the gaseous stream in time interval t on a dry basis; $V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval t on a wet basis; $FVR_{G,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Source of data	Measurements by Project participants using a flow meter
Value(s) applied	Not available

Measurement methods and procedures	Shall be monitored separately for the LFG gaseous stream delivered to the LFG delivery pipeline to the flare(s). The instruments with recordable electronic signal (analogical or digital) shall be installed. This parameter shall be continuously monitored by flow meters. The accuracy of monitoring equipment is according to national standard. Regarding parameters $V_{t,db}$ and $V_{t,wb}$, the volumetric flow rate of the residual gas at normal conditions in the hour h will be measured according to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", the measurement option in the project activity will be: Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; Option (B) wet basis: when the temperature of gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point; Regarding parameter $FVR_{G,h}$, Project Participant will ensure that the same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 ºC.
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment will be in accordance with manufacturer's specifications.
Purpose of data	Baseline emissions
Additional comment	NA

Data/Parameter	vi,t,db = fvi,h
Data unit	Nm³ CH_4 / m³ dry gas
Description	Volumetric fraction of greenhouse gas *i* in a hourly time interval *t* on a dry basis
Source of data	Measurements by project participants using a gas analyzer
Value(s) applied	Not available
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature Data will be monitored continuously and values will be averaged hourly or a shorter time interval, if feasible.
Monitoring frequency	Continuously
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gasor mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. The calibration frequency of this monitoring equipment should be according to the manufacturer's specifications.
Purpose of data	Baseline emissions
Additional comment	As a simplified approach, project participants may only measure the methane content of the gaseous stream and consider the remaining part asN_2, therefore i = CH_4

Data/Parameter	T_t
Data unit	K
Description	Temperature of the gaseous stream in time interval *t*
Source of data	Measurements by Project participant using a temperature meter
Value(s) applied	Not available
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous monitoring and hourly aggregated.
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications
Purpose of data	Baseline emissions
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency). However, if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted, this parameter must be monitored continuously to assure the applicability condition is met

Data/Parameter	Pt
Data unit	Pa
Description	Pressure of the gaseous stream in time interval *t*
Source of data	On site measurements
Value(s) applied	Not available
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) will be used.
Monitoring frequency	Continuous monitoring and hourly aggregated.
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) will be calibrated monthly
Purpose of data	Baseline emissions
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency)

Data/Parameter	$p_{H20,t,Sat}$
Data unit	Pa
Description	Saturation pressure of H2O at temperature Tt in time interval *t*
Source of data	Project participants
Value(s) applied	Not available
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] for a total pressure equal to 101,325 Pa
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	-
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Data/Parameter	Management of SWDS
Data unit	-
Description	Management of SWDS
Source of data	Use different sources of data: • Original design of the landfill; • Technical specifications for the management of the SWDS; • Local or national regulations
Value(s) applied	
Measurement methods and procedures	Project participants referred 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. However, there was no change that occurred due to project implementation. Any change in the management of the SWDS after the implementation of the project activity will be monitored and recorded.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$Op_{j,h}$
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Value(s) applied	Not available
Measurement methods and procedures	For each equipment unit *j* using *the LFG* monitor that the plant is operating in hour *h* by the monitoring any one or more of the following two parameters: • Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. e.g., the prescribed temperature for flare system is 1000°C in order to achieve 99.9% destruction; • Flame. Flame detection system is used to ensure that the equipment is in operation; e.g. the flare will be integrated with flame detection system. $Op_{j,h}$=0 when: • One of more temperature measurements are missing or below the minimum threshold in hour *h* (instantaneous measurements are made at least every minute); • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); Otherwise, $Op_{j,h}$=1
Monitoring frequency	Hourly
QA/QC procedures	Annual calibration/testing of the monitoring equipment would be undertaken by accredited agencies.
Purpose of data	Baseline emissions
Additional comment	-

Data/Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year *y*
Source of data	Electricity meter
Value(s) applied	Not available
Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG
Monitoring frequency	Continuous

QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Purpose of data	Baseline emissions
Additional comment	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

Data/Parameter	$EG_{EC,y}$
Data unit	MWh
Description	Amount of electricity consumed by the project activity in year *y*
Source of data	Electricity meter
Value(s) applied	Not available
Measurement methods and procedures	Sources of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications (power generators) etc.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Purpose of data	Project emissions
Additional comment	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process *t* ($PE_{EC,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

Data/Parameter	f_y
Data unit	-
Description	Fraction of methane captured at the SWDS and flare, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	Landfill records
Value(s) applied	0
Measurement methods and procedures	The prevailing contract and regulations do not prescribe any destruction of methane.
Monitoring frequency	Annual
QA/QC procedures	-
Purpose of data	Baseline emissions
Additional comment	The amount that is combusted in the baseline has already been considered as part of Case 3 of Step A.2 (as 20%)

Data/Parameter	$T_{EG,m}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Landfill records by project participants
Value(s) applied	Not available
Measurement methods and procedures	The temperature of the exhaust gas in the flare will be measured by an appropriate temperature measurement equipment. The measurements outside the operational temperature specified by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Flare manufacturers will provide suitable monitoring ports for the monitoring of the temperature of the flare. These would normally be expected to be in the middle third of the flare.
Monitoring frequency	Once per minute
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule. The calibration would be conducted once in a year or as specified by the manufacturer. .
Purpose of data	Baseline emissions
Additional comment	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. These events should be noted in the site records along with any corrective action that was implemented to correct the issue.

Data/Parameter	$Flame_m$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Source of data	Onsite measurements
Value(s) applied	Not available
Measurement methods and procedures	Measure using a fixed installation optical flame detector. Ultra violet detector or infra red
Monitoring frequency	Once per minute. Detection of flare 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 calibrated and maintained in in accordance with manufacturer's recommendations
Purpose of data	Baseline and project emissions
Additional comment	Applicable to all flares (Open or enclosed)

Data/Parameter	$TDL_{k,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j*, *k* or *l* in year *y*
Source of data	Project participants/National data
Value(s) applied	Default value, as appropriate (not available at this stage)
Measurement methods and procedures	In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options: • Use recent, accurate and reliable data available within the host country; • Use as default values of 20% for (a) project or leakage electricity consumption sources; (b) baseline electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is larger than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies. • Use as default values of 3% for (a) baseline electricity consumption sources; (b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.
Monitoring frequency	Annually, In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
QA/QC procedures	For a): $TDL_{j/k/l,y}$ should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.
Purpose of data	Baseline emissions and project emissions
Additional comment	-

B.7.2. Sampling plan

No sampling plan applied.

B.7.3. Other elements of monitoring plan

The monitoring plan will be done according to the methodology ACM0001 and the applicable tools. The monitoring equipment locations are presented in the picture below:

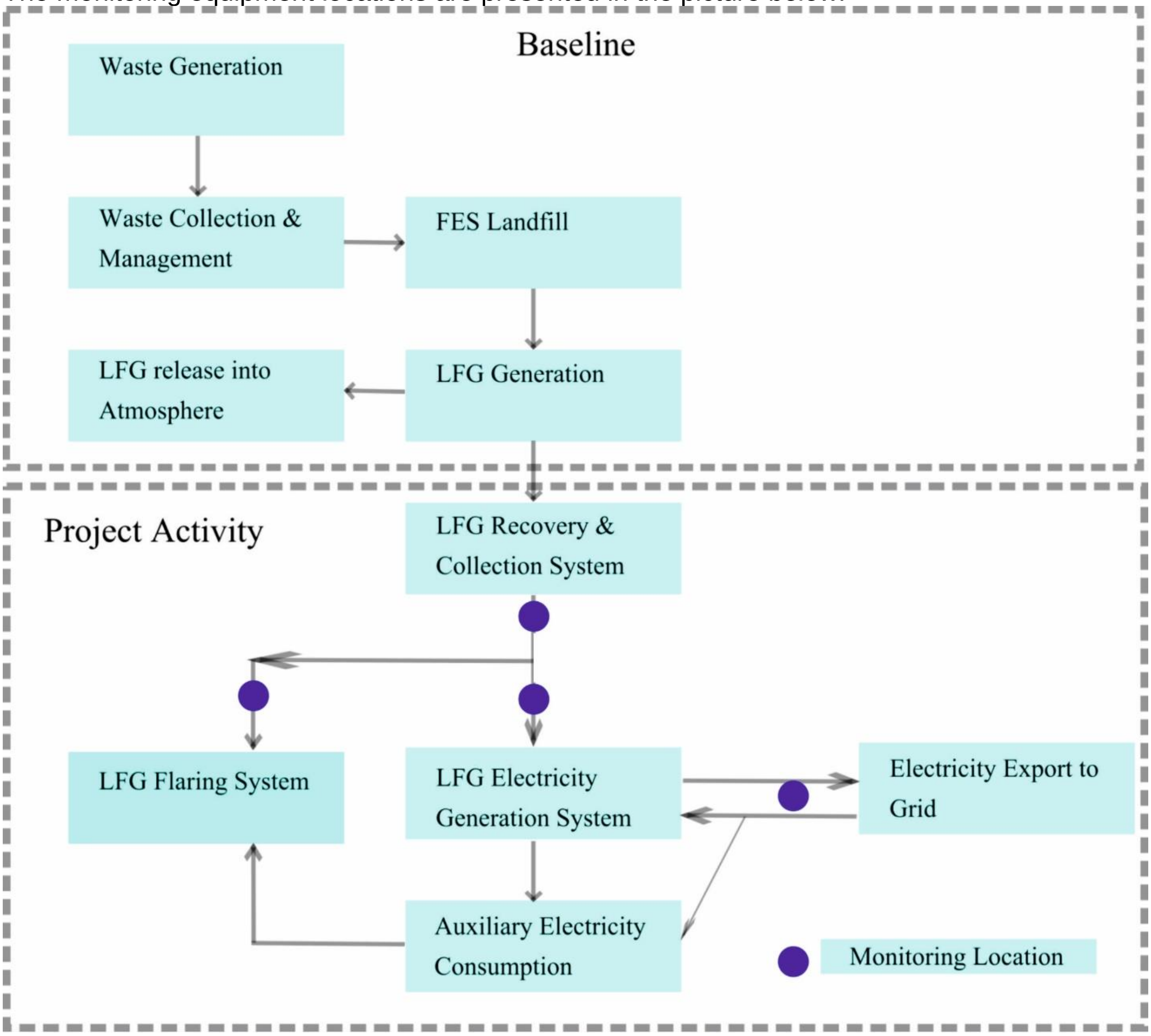


Figure 2: Schematic of the monitoring system at Fes Landfill

The variables to be monitored were all listed and described in Section B.7.1.

The overall management structure responsible for project monitoring is as follows:

The landfill is owned and operated by Ecomed Gestion des Dechets (hereinafter ECOMED). They would be involved in investments for gas collection, power generation and thermal treatment of leacahte, as well as additional operation, maintenance and monitoring costs.

The Technical Team of ECOMED will be responsible for the day-to-day operation of the landfill gas collection, flaring and use system. This Technical Team would also be responsible for monitoring key variables required for meeting the CDM monitoring requirements.

Data monitoring will be conducted by Landfill Gas Technical Operators supervised by the Landfill Gas Project Engineer, all of them belonging to the Planning and Development Department of ECOMED. Other staff persons will be assigned by the Landfill Gas Project Engineer to assist in the monitoring tasks, as needed.

Certain activities (calibration of flow meters and electric meters) would be conducted by independent, outside laboratories, with the data archived by the ECOMED Planning and Development Department.

ECOMED will count on supervision from the flare supplier for training, commissioning and start-up. If ECOMED decides to generate electricity using landfill gas, ECOMED will also acquire either from equipment supplier and/or specialist consultant all the services needed for training related to the operation of the LFG generation system. ECOMED staff to be trained will be selected from those with extensive experience at the landfill.

All data recorded would be transferred to and stored as electronic spreadsheets and other electronic files. Calibration certificates would be stored as paper copies, although scanned copies may also be stored electronically. ECOMED Planning and Development Department will be responsible for oversight on all aspects involving monitoring and quality control. ECOMED Operations Department will maintain copies of all data collected, including calibration certificates for all instruments.

Following the internal audit, the electronic data would be used in a spreadsheet procedure in order to calculate emissions reductions. The original data, the calculation procedures and the resulting emission reductions will be verified by an independent Designated Operational Entity (DOE). The DOE would issue a Verification Report based on its findings and submit it to the CDM Executive Board for the issuance of CERs.

The operational and management structure for specific monitoring tasks is described in the following table:

#	Task name	Responsible	Frequency	Internal procedures of Quality Control	Documentation
1	Monitoring of parameters	Planning and Development Department of ECOMED	As per B.7.1 against parameter	Yes	The data will be monitored and filed by the ECOMED Planning and Development Department.
2	Calibration of the flow meters	External calibration laboratory	As per B.7.1 against parameter	Yes	Calibration certificate will be issued by the Calibration Laboratory. This certificate will be filed by the ECOMED Planning and Development Department.
3	Electricity generation and consumption from the grid	Planning and Development Department ECOMED	As per B.7.1 against parameter	Yes	Data tables showing date, hour, and meter reading to be recorded in a spreadsheet file, and filed by the person responsible for data filing and the Head of the ECOMED Planning and Development Department.
4	Fossil fuel use (diesel, propane), if any	Planning and Developmen	Fossil fuel purchase will be	Yes	Data tables showing date and amount of fossil fuel (diesel)

		t Department ECOMED	recorded on delivery, with totals recorded monthly		Purchased (data obtained from invoices) to be recorded in a spreadsheet file by the person responsible and checked by ECOMED Planning and Development Department.
5	Operation of the flare station(s), power plant(s)	Planning and Development Department ECOMED	As per B.7.1 against parameter	Yes	The data will be monitored and filed by the ECOMED Planning and Development Department.
6	Electric meter calibration	External calibration laboratory	As per B.7.1 against parameter	Yes	Calibration certificate will be issued by the Calibration Laboratory. This certificate will be filed by the ECOMED Planning and Development Department.
7	Internal Audit	ECOMED Operations Department	Twice a year	Yes	The internal auditor will prepare a report to the Manager of the landfill site and the Head of ECOMED Planning and Development Department on the state of items 1 to 8. In case of nonconformity, they will attempt to resolve problems prior to the annual Verification carried out by a Designated Operational Entity. A copy of this report should be filed in the ECOMED Operations Department and the Planning and Development Department
8	Data Archiving	ECOMED Operations Department	Crediting period+2years	Yes	ECOMED will be responsible for proper upkeep of the monitored data
9	Emergencies	ECOMED Operations Department	Project lifetime	Yes	ECOMED will be responsible as how to deal with the emergency situations with regard to monitored data.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

24/01/2008
The project activity started on January 24, 2008 when the project developer committed expenditures and purchased the blowers, flare and pre-treatment equipment for the biogas.

C.2. Expected operational lifetime of project activity

The contract between project developer and the Commune Urbaine de Fes is valid until the December 2031. The operational lifetime of the equipment with the proper maintenance program is 15 years.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

Fixed crediting period

C.3.2. Start date of crediting period

01/10/2013 or date of registration, whichever is later.

C.3.3. Duration of crediting period

10 years 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The project activity, landfill gas collection and flaring, is a supplementary part of the Sanitary landfill operations. Although not required by the existing regulations at the time, An Environmental Impact Assessment for the Fes Landfill was prepared by Sadat International Inc. (SII) in 1999, as a part of the solid waste management plan for the city of Fes. The assessment concludes that the project will give rise to a large number of positive impacts associated thereto, and no significant negative residual impacts have been detected.

Below are the additional positive impacts that could results from the landfill Gas Capture and Flaring System at the Fes Sanitary landfill.

Environmental:
Capturing and flaring the landfill gas is an effective way of preventing the emission of methane into the atmosphere, thus reducing the release of gases having a greenhouse effect, and therefore minimizing contribution to global warming.
Besides, this methodology permits extracting and channeling the gases generated within the sanitary landfill, accordingly increasing the sanitary landfill stability.
In addition, flaring of the collected LFG does not only destroy methane, but will also destroy compounds in the LFG such as volatile organic compounds and ammonia This gas management methodology will decrease the emission of gases to the atmosphere, thus improving air quality in the surrounding area.

Socio-economic:
The sale of CERs earned by implementing the project will generate a substantial flow in foreign currency to the Commune Urbaine de fes. This income will be shared with the Commune and can be used for the research and promotion of new Sustainable-Development Projects.

The construction, operation and maintenance of the system will result in about 8 new direct jobs in the project area.

This project will promote new projects within the Clean Development Mechanism at national and provincial levels. The project will be a vehicle for technological development in the Province, and will permit the engagement and formation of specialists and new projects in the field of the capture of the Landfill gas, so as to overcome the technological barriers presented by this type of project.

D.2. Environmental impact assessment

No potential negative residual impacts have been identified in relation to the project.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

The operator of the Fes landfill has continuously interacted with local stakeholders, both for the dissemination of information associated to the management plan of the landfill, and for different improvement projects involved in such plan, especially the project reviewed herein.

The project was presented at the Wilaya of Fes on June 7, 2005 at the occasion of the world environment day. All the stakeholders were invited, including ministerial, provincial and municipal representatives, press, academic community, provincial and municipal legislators and neighbors. A visit to the landfill was also organized on the same day.

In August 2006, the Ministry of Interior approved the Agreement between the consortium Ecomed-Edgeboro and the Commune Urbaine de Fes to Capture and Use of Gases from the Fes Sanitary landfill. The agreement describes the main features of the project, the benefits pursued and the predicted results.

E.2. Summary of comments received

The comments received from the local population have been encouraging, insofar as they evidenced an understanding of the significance of a project of this type and the likelihood of new associated projects in the future. Ministerial, provincial and municipal representatives showed their support for the project, and emphasized its importance as the first in its type in the Province and as an opening for new opportunities of Sustainable Development.

The academic and political community showed great interest in the project because it promotes social development by including state-of-art technology in the Province.

The neighbors are interested in the project since it will reduce the problems of odors from the landfill. No negative comments have been received from any of the interested parties.

E.3. Consideration of comments received

The queries stated during the meetings and presentations were answered and clarified at the meetings. Such queries did not result in any comments that could cause changes to be done to this Project Design Document.

SECTION F. Approval and authorization

The Letter of Approval (revised) has been obtained (dated 29 Dec 2009) and provided to DOE.

Appendix 1. Contact information of project participants

Organization name	Ecomed Gestion des Dechets
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Website	
Contact person	Mr. Hamid Chabat(President)

Appendix 2. Affirmation regarding public funding

The project sponsors will not receive any public funding for the development of the proposed CDM project.

Appendix 3. Applicability of methodologies and standardized baselines

Relevant information has been included in the main section of the PDD.

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

Relevant information has been included in the main section of the PDD.

Appendix 5. Further background information on monitoring plan

Relevant information has been included in the main section of the PDD.

Appendix 6. Summary report of comments received from local stakeholders

Relevant information has been included in the main section of the PDD.

Appendix 7. Summary of post-registration changes

The proposed Post Registration Changes are:

Changes	Category of Changes	Reason
Capacity of the power generation units has been revised to 1.067MW X 2. The financial analysis is revised based on revised cost of gas engines. Estimated emission reduction are also revised based on the revised capacity.	Permanent Changes: Changes to the project design	Power generation depends on the availability of the Methane/gas. Based on internal evaluation the gas engine is procured based on the availability of Methane.
Revision in monitoring frequency for parameter Tt: Temperature of the gaseous stream in time interval *t* frequency of aggregation has been added.	Permanent changes: Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines or other applied methodological regulatory documents	The monitoring frequency is continuous as per registered PDD. The frequency is updated and it is now as per actual implementation at site. The monitoring frequency is continuous and aggregated hourly.
Revision in monitoring frequency for parameter Pt: Pressure of the gaseous stream in time interval *t* frequency of aggregation has been added.	Permanent changes: Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines or other applied methodological regulatory documents	The monitoring frequency is continuous as per registered PDD. The frequency is updated and it is now as per actual implementation at site. The monitoring frequency is continuous and aggregated hourly.
Temporary deviation is proposed for period 12 March 2015 to 30 April 2018 as no monitoring was taking place due to implementation delays. Furthermore, for period from June 2015 to Feb 2018 the monitoring on ground was not exactly as per registered PDD in terms of frequency; the monitoring frequency of the parameter methane percentage in biogas was monitored on daily basis and not continuously as required by registered PDD. Hence, monthly values have been used to compute the ERs for this period.	Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines	Delay in installation of SCADA system. The SCADA system was installed on 11/02/2018 and started recording of the parameters inline to the registered PDD.
Editorial changes and changes in line with the new PDD template version.	Permanent Changes: Correction	Editorial changes, changes required in line with new PDD template.

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Document information

Version	Date	Description
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.

Version	*Date*	*Description*
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document