Monitoring report form for CDM project activity
(Version 07.0)

MONITORING REPORT		
Title of the project activity	Fes New Landfill Gas Recovery Reuse and Flaring Project	
UNFCCC reference number of the project activity	9761	
Version number of the PDD applicable to this monitoring report	16.1	
Version number of this monitoring report	3.2	
Completion date of this monitoring report	14/01/2021	
Monitoring period number	1	
Duration of this monitoring period	12/03/2015 - 30/04/2018	
Monitoring report number for this monitoring period	01	
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	1: Energy industries (renewable - / non-renewable sources 13: Waste handling and disposal)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO_2e	11,869 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	365,759 tCO2e	

SECTION A. Description of project activity

A.1. General description of project activity

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Pre-project Scenario

The pre project scenario is O&M of the landfill without utilizing the landfill gas (LFG) 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 are no existing regulations in the country to burn the LFG thus generated and is neither covered under the scope of O&M agreement of landfills, it is still burnt randomly for almost 10 days stretching in a year to reduce the fire hazard. The O&M contractor records the number of days it is flared. The net electricity generated in the project is transferred to the national grid, thus reducing the amount of GHG emissions produced by electricity generation via non-renewable fuel burning. The leachate collected currently is left as such to get sun dried.

Project's Objectives

The Fes New Landfill Gas Recovery, Reuse and Flaring Project, hereafter referred to as the "Project", is a landfill gas collection, utilization, and flaring project taking place at the new landfill of the City of Fes, Morocco, hereafter referred to as the "Host Country". Ecomed, hereafter referred to as the "Project Developer", is developing the Project.

The Project's objective is capture and destruction of landfill gas from the new landfill site in order to reduce the potential local impacts of odor, explosions and fire hazards associated with landfill gas, and to reduce the fugitive emissions of the greenhouse gas methane contained in the landfill gas, which contributes to global warming and climate change.

Project's Activities

The description in the registered PDD for project activity was the installation of enhanced landfill gas extraction and flaring equipment for the destruction of the landfill gas and the installation of electricity generation equipment (aggregating to 3.0 MW i.e., 375 kW * 8 units) using landfill gas, for the production of onsite electricity. The installation capacity 3.0MW was proposed based on estimated biogas recovery subject to actual check after operation of landfill. However, during actual operation the biogas generation is found to be lower than estimated, hence, the PP has revised the power generation capacity to 2.134MW.

The revised power generation equipment comprises 2 gas engines having individual capacity of 1.067MW each. The first gas engine is commissioned dated is 12/03/2015 and the second gas engine is not commissioned. The revision is proposed as part of post registration changes along with verification. The project activity involves combustion of methane extracted from the landfill gas, which will lead to the reduction in amount of greenhouse gas emissions. In practice, the captured LFG is utilized in the gas engines for generation of electricity. The generated electricity is sold to the grid after factoring the auxiliary consumption of the gas engines on project site. In the events causing excess of LFG, e.g. when gas engines are not operating, it gets combusted in the flare system.

The landfill gas recovery and flaring are commissioned and operational since then with normal operation and maintenance. The first gas engine is commissioned on 12/03/2015 and operational during current monitoring period.

During current monitoring period the project activity has partially flared and used remaining landfill for electricity generation, the project activity has supplied net electricity 13,650.26 MWh to grid. The project activity has resulted 11,869 tCO_2e emission reduction during current monitoring period i.e. 12/03/2015 to 30/04/2018.

A.2. Location of project activity

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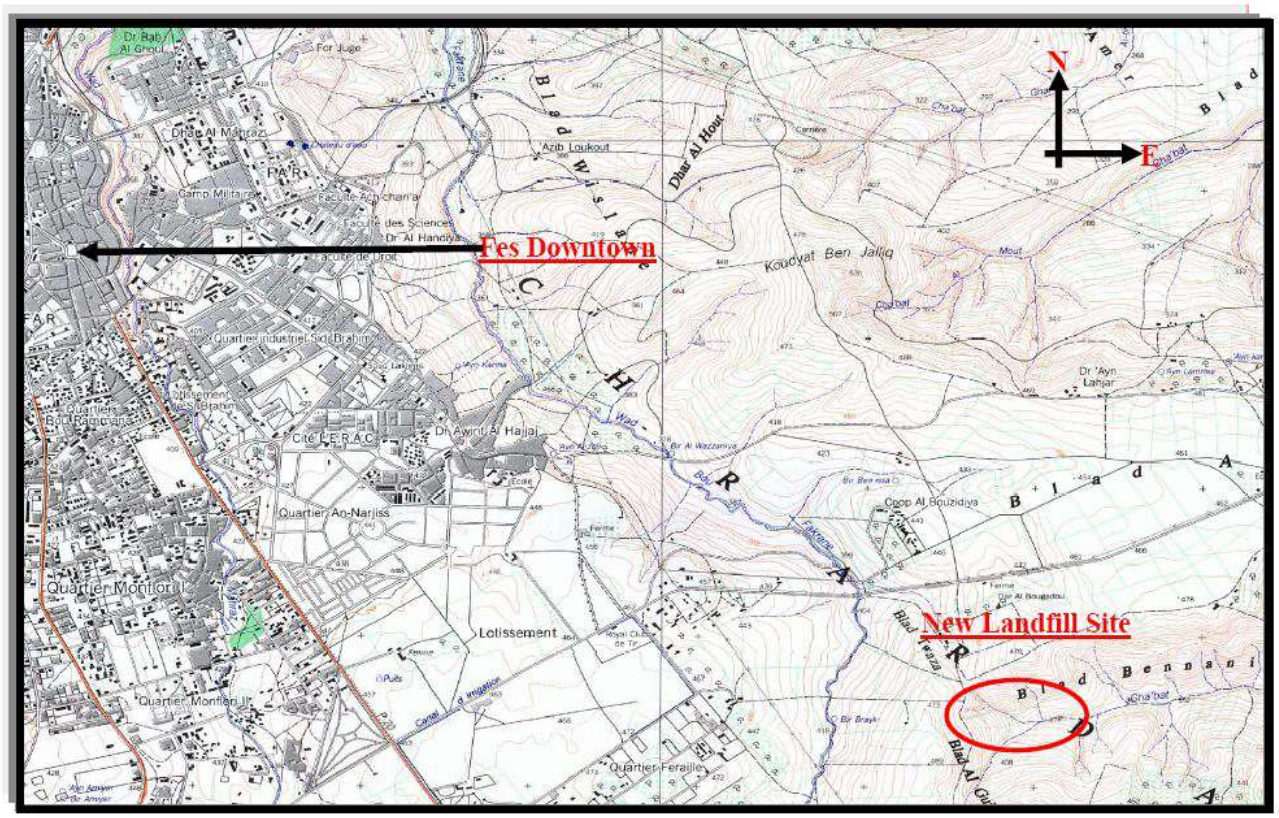
Host Country: Morocco
Region/State/Province: Wilaya de Fes-Boulemane
City/Town/Community: Fes

Physical/Geographical location: 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. 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.4. References to applied methodologies and standardized baselines

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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.
https://cdm.unfccc.int/methodologies/DB/EYUD9R1ZAUZ2XNZXD3HQH18OK3VWIV

The other methodological tools referred and applied in the PDD are as under:

- Emissions from solid waste disposal sites (Version 06.0.1) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v6.0.1.pdf/history_view
- Combined tool to identify the baseline scenario and demonstrate additionality (Version 05.0.0) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v2.2.pdf/history_view
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption (Version 01) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf/history_view
- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 02) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf/history_view
- Project emissions from flaring (Version 02.0.0) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf/history_view
- Tool to calculate the emission factor for an electricity system (Version 03.0.0) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf/history_view
- Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 02.0.0) https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v1.pdf/history_view

A.5. Crediting period type and duration

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The project activity has fixed crediting period of 10 years starting from 12/03/2015. The crediting period is from 12/03/2015 to 11/03/2025 (includes first and last days).

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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The description of implementation of the project activity is as below

Landfill Gas Collection System

The project activity involves the installation of LFG collection technology. This includes:

• Gas Collection Wells used to extract gas;

• Blowers to draw the LFG into the flare and/or the energy generator;

• Landfill capped by soil to provide cover for the site;

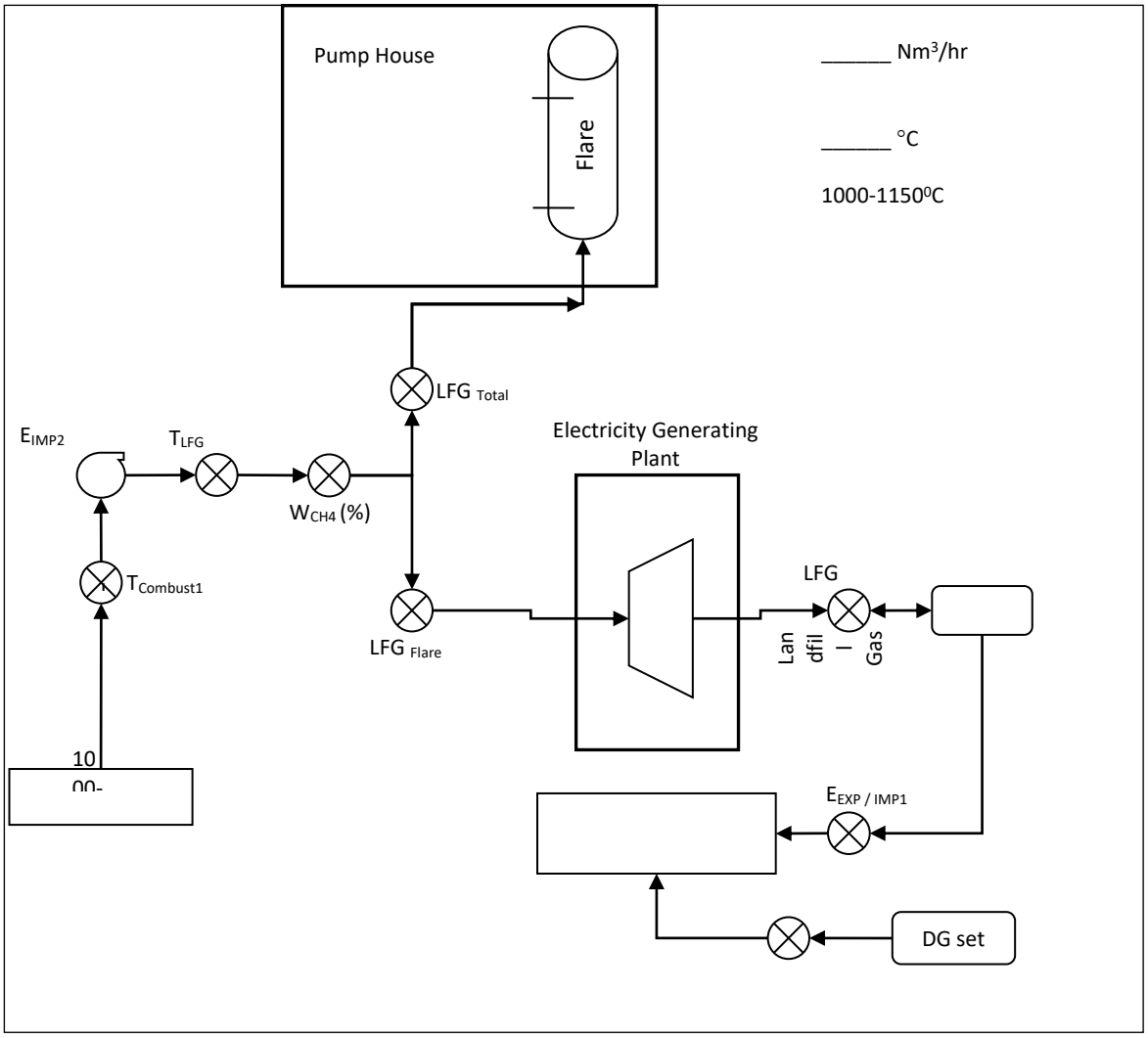
Flare technology:

The project activity involves the installation of a stationary enclosed gas flare consisting of pipe work, valves, blower, stack with burners, instrumentation and control panel. The details of the installed flare are as follows:

Description	Make	Flow capacity range (Nm^3/h)	Combustion temperature range (^0C)	Manufacturing Year

Flare	Biogas Technology Limited, UK	2000Nm3/h	1000 – 1150	2010

The project activity is demonstrated in the line diagram below:



Electricity generation technology:

The project has an installed electricity generation capacity of 1067kw using captured landfill gas as follows:

Description	Make	Rated Power (kw)	Manufacturing Year
Gas Engine Generator	Jenbacher GE	1067	2012

The project activity was commissioned on 12/03/2015 was operational during current monitoring period with normal operation and maintenance. There were no major shut down/break down during current monitoring period i.e. from 12/03/2015 to 30/04/2018.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

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The temporary deviation is proposed for period 12/03/2015 to 30/04/2018 as no monitoring was taking place due to implementation delays. Furthermore, for the period from 01/06/2015 to 28/02/2018 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. In view of conservativeness, the PP has not claimed the emission reductions until 28/02/2018 from methane avoidance. PP has claimed the emission reduction for power generation only during the above period.

B.2.2. Corrections

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Section A.3 is updated, and technical details are revised due to change in design capacity of the project. Editorial changes and changes in line with the new PDD template version.

B.2.3. Changes to the start date of the crediting period

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The start date of crediting period was changed from 13/03/2014 to 12/03/2015 prior to the publication of MR.

B.2.4. Inclusion of monitoring plan

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There is no inclusion of monitoring plan to the registered PDD that was not included during registration.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

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Revision in monitoring frequency for parameter Tt: Temperature of the gaseous stream in time interval *t* frequency of aggregation has been added.

Revision in monitoring frequency for parameter Pt: Pressure of the gaseous stream in time interval *t* frequency of aggregation has been added.

B.2.6. Changes to project design

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The changes to the project design is proposed from registered PDD. The proposed change is revision in the installed capacity of gas engines (reduction from 3 MW to 2.134 MW) of the project size due to low biogas availability. Further the capacity of individual gas engine is changed from 375kW to 1067kW, which resulted in change in the number of gas engine from 8 to 2. The revised capacity will comprise 2 gas engines with installed capacity 1067kW each having aggregated installed capacity 2.134MW.

B.2.7. Changes specific to afforestation or reforestation project activity

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Not applicable

SECTION C. Description of monitoring system

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A single line diagram (SLD) is included in Section B.1 of the MR where all monitoring locations are indicated.

Data generation: Total LFG captured and LFG sent to generator and/or the flare is continuously measured by the flow meters. Methane fraction in LFG is measured by a continuous gas analyzer and electricity exported and imported are measured continuously by electricity meter(s) (please see section D.2 for details).

Data recording: Measurements of the quantity of total LFG captured, and LFG sent to the generator and/or the flare are recorded electronically on an hourly basis. Methane fraction readings are recorded continuously every hour. Electricity meter readings are recorded manually every month. All manual recordings are subsequently entered in an excel sheet.

Data aggregation: The monitored landfill gas data and electricity supplied to the grid are respectively summed over the monitoring period.

Calculation: see section D.2 and section E.

Reporting: The calculated values are included in an Excel sheet and reported in the CDM-MR.

Clear roles and responsibilities have been assigned to all staff involved in the CDM project, as described in the monitoring manual.
All staff involved in the collection of data and records are coordinated by the designated 'CDM Monitoring Manager.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	**OX_{top_layer}**
Unit	Dimensionless
Description	Fraction of methane that is 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/parameter	Baseline calculations
Additional comments	NA

Data/Parameter	$F_{CH4,BL,x-1}$
Unit	t CH_4/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/parameter	Baseline emissions
Additional comments	This term is synonymous to $F_{CH4,BL,sys,y}$

Data/Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
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 II commitment period
Purpose of data/parameter	Baseline emissions
Additional comments	The value has changed from 21 to 25, as per IPCC for second commitment period.

Data/Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that is 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/parameter	Baseline emissions
Additional comments	The value is conservative from additionality perspective and is used only for the purpose of ex ante estimation of CERs

Data/Parameter	$\Phi_{default}$
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/parameter	Baseline emissions
Additional comments	NA

Data/Parameter	OX
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	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/parameter	Baseline emissions
Additional comments	-

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

Data/Parameter	$DOC_{f,default}$
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/parameter	Baseline emissions
Additional comments	-

Data/Parameter	$MCF_{default}$
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/parameter	Baseline emissions
Additional comments	-

Data/Parameter	DOC_j					
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	Food	Paper Cardboard	Wood	Textile	Garden Waste	Plastic, metal, glass, other inerts
	50.3%	7.4%	0.0%	5.7%	7.8%	28.8%
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/parameter	Baseline emissions					
Additional comments	-					

Data/Parameter	**K_j**
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/parameter	Baseline emissions
Additional comments	-

Data/Parameter	**$EF_{EL,k,y}$**
Unit	tCO_2e/MWh
Description	CO_2 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, tCO_2e/MWh.
Source of data	Tool to calculate baseline, project and/or leakage emissions from electricity consumption Version 1
Value(s) applied	0.4
Choice of data or measurement methods and procedures	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);

	Power Generation (GWh)		Average share of Hydro
Year	Hydro	Total	%
2012	1631	26495.5	6.15
2011	2005.3	24363.6	8.23
2010	3467.8	22851.4	15.17
2009	2568.5	20809.2	12.34
2008	916.2	20306.8	4.51
Total	10588.8	114826.5	9.22
Average over 5 years:			9.28

This value can be used if
(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.

Purpose of data/parameter	Baseline and project emissions
Additional comments	A single, fixed value is used for entire crediting period.

Data/Parameter	$SPEC_{flare}$

Unit	Temperature - °C Flow rate or heat flux - kg/h or Nm^3/h Maintenance schedule - number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	Minimum - Maximum flow rate = 500 Nm3/h to 2000 Nm^3/h) Minimum – Maximum operating temperature = 1000 °C to 1150 °C) Maintenance schedule – Not available/specified
Choice of data or measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare as specified above.
Purpose of data/parameter	Project emissions
Additional comments	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

Data/Parameter	η_{flare}
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/parameter	Project emissions
Additional comments	-

D.2. Data and parameters monitored

Data/Parameter	Vt,db / Vt,wb / FVRG,h (FCH4,EL,y)
Unit	Nm^3 /h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h.
Measured/calculated/ Default	Measured
Source of data	Measurements using a flow meter
Value(s) of monitored parameter	7,542,635.76 (for entire monitoring period) 584,794 (claimed for ER purposes for Mar 2018 and Apr 2018)

<table>
<tr><td>Monitoring equipment</td><td>Flow meters<table><tr><td>Period</td><td>June 2015 to Mar 2017</td><td>Apr 2017 to Mar 2018</td></tr><tr><td>Make</td><td>Endress+Hauser</td><td>Endress+Hauser</td></tr><tr><td>Type</td><td>Proline t-mass 65</td><td>Proline t-mass 65</td></tr><tr><td>Serial Number</td><td>D40AAE02000</td><td>K108D402000</td></tr></table>Accuracy class: 1% of flow rate
Calibration date: 10/02/2015
Validity of calibration: 5 years from the date of calibration</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The values are monitored continuously and recorded Hourly.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer’s specifications.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline emissions</td></tr>
<tr><td>Additional comments</td><td>NA</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>Vt,db / Vt,wb / FVRG,h (FCH4,sent_flare,y)</td></tr>
<tr><td>Unit</td><td>Nm³ /h</td></tr>
<tr><td>Description</td><td>Volumetric Flow rate of LFG to Flare</td></tr>
<tr><td>Measured/calculated/ Default</td><td>Measured using flow rate meters</td></tr>
<tr><td>Source of data</td><td>Measurements by Project participants using a flow meter</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>1,854,721.14 (for entire monitoring period)
116,493 (claimed for ER purposes for Mar 2018 and Apr 2018)</td></tr>
<tr><td>Monitoring equipment</td><td>Flow rate meters<table><tr><td>Period</td><td>June 2015 to Mar 2018</td></tr><tr><td>Make</td><td>Endress+Hauser</td></tr><tr><td>Type</td><td>Proline t-mass 65</td></tr><tr><td>Serial Number</td><td>D40AB002000</td></tr></table>Accuracy class: 1% of flow rate
Calibration date: 10/02/2015
Validity of calibration: 5 years from the date of calibration</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>The values are monitored continuously and recorded Hourly.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>NA</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meter is subject to a regular maintenance regime to ensure accuracy.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline emission calculation</td></tr>
<tr><td>Additional comments</td><td>NA</td></tr>
</table>

Data/Parameter	**vi,t,db = fvi,h**
Unit	%
Description	Volumetric fraction of methane in a hourly time interval *t* on a dry basis
Measured/calculated/ Default	Measured
Source of data	Measurements by project participants using a gas analyzer
Value(s) of monitored parameter	60.31% (average over current monitoring period) 60.58% (claimed for ER purposes for Mar 2018 and Apr 2018)
Monitoring equipment	Gas analyser Following are the specifications of the Gas analyser used for measurement of this parameter: **Make**: EATON **Series**: CROUSE-HINDS **SN**: I-11321 **Type**: GIR5500 **Range**: 0-50000 ppm Accuracy: 2% Calibration date: 03/03/2015 Validity of calibration: 5 years from the date of calibration
Measuring/reading/recording frequency	The values are monitored continuously and recorded Hourly.
Calculation method (if applicable)	NA
QA/QC procedures	Calibration includes zero verification with an inert gas (e.g. N2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). The calibration frequency of this monitoring equipment is in accordance to the manufacturer's specifications.
Purpose of data/parameter	Baseline emissions
Additional comments	-

Data/Parameter	Tt
Unit	°C
Description	Temperature of the gaseous stream in time interval *t*
Measured/calculated/ Default	Measured
Source of data	Measurements by Project participant using a Digital Thermometer
Value(s) of monitored parameter	Refer ER Sheet
Monitoring equipment	Digital Thermometer, Rototherm, Resolution 1 °C Type: S Accuracy: +/- 1.0^{o} C Calibration date:03/03/2015 Validity of calibration: 4 yrs from the date of manufacturing/initial calibration
Measuring/reading/recording frequency	The values are monitored continuously and recorded Hourly
Calculation method (if applicable)	NA
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is done. Calibration and frequency of calibration is according to manufacturer's specifications
Purpose of data/parameter	Baseline emissions

Additional comments	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	P_t
Unit	m Bar
Description	Pressure of the gaseous stream in time interval *t*
Measured/calculated/ Default	Measured
Source of data	On site measurements
Value(s) of monitored parameter	Refer ER Sheet
Monitoring equipment	Pressure meter Make: WIKA SN: 13065416 S Accuracy class:0.1 Calibration date:07/03/2015 Validity of calibration: 4 years
Measuring/reading/recording frequency	The values are monitored continuously and recorded Hourly.
Calculation method (if applicable)	NA
QA/QC procedures	Periodic calibration against a primary device is performed and records of calibration procedures are 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/parameter	Baseline emissions
Additional comments	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	**Management of SWDS**
Unit	-
Description	Management of SWDS
Measured/calculated/ Default	Estimated
Source of data	Use of different sources of data: • Original design of the landfill; • Technical specifications for the management of the SWDS; • Local or national regulations
Value(s) of monitored parameter	Is being managed as per local regulation/contract
Monitoring equipment	No
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	-

QA/QC procedures	-
Purpose of data/parameter	Baseline emissions
Additional comments	-

Data/Parameter	**$Op_{j,h}$**
Unit	Every hour
Description	Operation of the equipment that consumes the LFG
Measured/calculated/ Default	Measured
Source of data	On-site records
Value(s) of monitored parameter	Refer ER sheet, cell B in sheet Feb, March, April
Monitoring equipment	Scada time meter
Measuring/reading/recording frequency	Monitored continuously, recorded hourly
Calculation method (if applicable)	NA
QA/QC procedures	-
Purpose of data/parameter	Data is monitored to ensure methane destruction is claimed for methane used in on site equipment when it is operational
Additional comments	-

Data/Parameter	**$EG_{PJ,y}$**
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year *y*
Measured/calculated/ Default	Measured
Source of data	On-site records
Value(s) of monitored parameter	13,662.51
Monitoring equipment	Energy Meter Make: ISKRA Type: A12E Serial number: N35800044 Accuracy Class: 1 Calibration date:12/03/2015 Validity of calibration: 5 years from the date of last calibration
Measuring/reading/recording frequency	Measured continuously using energy meters. Recorded monthly.
Calculation method (if applicable)	Electricity export – Electricity import
QA/QC procedures	The electricity meter is subject to regular maintenance in accordance with stipulation of the meter supplier to ensure accuracy.
Purpose of data/parameter	Baseline emission calculations
Additional comments	-

Data/Parameter	**$EG_{EC,y}$**
Unit	MWh
Description	Amount of electricity consumed by the project activity in year *y*
Measured/calculated/ Default	Calculated
Source of data	On-site records
Value(s) of monitored parameter	12.248
Monitoring equipment	NA
Measuring/reading/recording frequency	Calculated and recorded monthly
Calculation method (if applicable)	Metered electricity consumption Make: ISKRA Type: A12E Serial number: N35800044 Accuracy Class: 1 Calibration date:12/03/2015 Validity of calibration: 5 years from the date of last calibration
QA/QC procedures	The meter(s) are maintained in accordance with stipulation of the supplier to ensure accuracy.
Purpose of data/parameter	Project emission calculation
Additional comments	The project emissions from electricity imported from Grid are already account in the calculation of EL_{LFG} (as net of export and import from grid)

Data/Parameter	**$T_{EG,m}$**
Unit	^{o}C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Measured/calculated/ Default	Measured
Source of data	On-site records
Value(s) of monitored parameter	Refer ER sheet
Monitoring equipment	Embedded in SCADA Flare system Rototherm, Resolution 1 deg C Type:S Accuracy: +/- 1.0^{o} C Calibration date:03/03/2015 Validity of calibration: 4 yrs from the date of manufacturing/initial calibration
Measuring/reading/recording frequency	Measured hourly
Calculation method (if applicable)	NA
QA/QC procedures	
Purpose of data/parameter	Project and Baseline emission calculation
Additional comments	-

Data/Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Measured/calculated/ Default	Measured
Source of data	On-site measurement
Value(s) of monitored parameter	Refer ER sheet
Monitoring equipment	Optical flame detector
Measuring/reading/recording frequency	Recorded minute basis
Calculation method (if applicable)	NA
QA/QC procedures	Equipment is maintained in accordance with manufacturer's recommendations
Purpose of data/parameter	Baseline and project emissions
Additional comments	Applicable to all flares (Open or enclosed)

Data/Parameter	$TDL_{k,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *j*, *k* or *l* in year *y*
Measured/calculated/ Default	Default
Source of data	National data (as reported by the grid)
Value(s) of monitored parameter	20%
Monitoring equipment	-
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	-
QA/QC procedures	External data
Purpose of data/parameter	Baseline emissions and project emissions
Additional comments	-

D.3. Implementation of sampling plan

>>

Not applicable as all parameter monitored

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>>

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

Where:

BE_y Baseline emissions in year *y* [tCO_2e];

$BE_{CH4,y}$ 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 is trimmed as under;

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

Baseline emissions associated with methane emission from SWDS ($BE_{CH4,y}$)

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

Determination of $F_{CH4,PJ,y}$

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

Where:
$BE_{CH4,y}$ Baseline emissions of LFG from the SWDS in year *y* (t CO2e/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)
$F_{CH4,flared,y}$ 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* (tCH_4/yr)

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

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 of residual gas stream in year y (t CO_2e/yr)
GWP_{CH4} Global warming potential of CH_4 (tCO_2e/t CH_4)

$F_{CH4,sent\_flare,y} = V_{t,db}(F_{CH4,sent\_flare,y}) * vi,t,db * \rho_{CH4,t}$
$F_{CH4,EL,y} = V_{t,db}(F_{CH4,EL,y}) * vi,t,db * \rho_{CH4,t}$

With

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

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

$V_{t,db}(F_{CH4,sent\_flare,y})$	Volumetric Flow rate of LFG to flare
$V_{t,db}(F_{CH4,EL,y})$	Volumetric Flow rate of LFG to Gas Engines
$v_{i,t,db}$	Volumetric fraction of methane in the gaseous stream in a time interval *t* on a dry basis (m^3 /m^3)
$\rho_{CH4,t}$	Density of methane in the gaseous stream in time interval *t* (kg/m^3)
P_t	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{CH4}	Molecular mass of methane(kg/kmol)
Ru	Universal ideal gases constant (Pa.m3/kmol.K)
T_t	Temperature of the gaseous stream in time interval *t* (K)

The density of methane is established in registered PDD as below
$\rho_{CH4,t}$ = 0.000716 tCH_4/m^3 CH_4

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

$PE_{flare,y}$	Project emissions from flaring of the residual of residual gas stream in year y (t CO_2e/yr)
GWP_{CH4}	Global warming potential of CH_4 valid for commitment period (tCO_2e/t CH_4)
$F_{CH4,RG,m}$	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	Flare efficiency in minute m

Determination of $F_{CH4,BL,y}$
When there is no requirement to destroy methane and a LFG capture system exists, then

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

Where,

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

Where,

$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH4/yr)
$F_{CH4,BL,sys,y}$	Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (t CH4/yr)
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH4/yr)

For period 12/03/2015 to 30/04/2018 no monitoring was taking place due to implementation delays. Furthermore, for period from 01/06/2015 to 28/02/2018 the monitoring on ground was not exactly as per registered PDD in terms of frequency of monitoring. The biogas capture and utilization were happening during current monitoring period, however, as a conservative approach, PP has decided not to claim emission reduction from methane component from period 12/03/2015 to 28/02/2018.

The baseline emissions from 01/03/2018 to 30/04/2018 is presented below

$V_{t,db}(F_{CH4,sent\_flare,y})$= 116,493 Nm^3
$V_{t,db}(F_{CH4,EL,y})$ = 584,794 Nm^3

The methane percentage average over period 01/03/2018 to 30/04/2018 is 60.59% ($v_{i,t,db}$)

The baseline emission calculated for 2 months i.e. from 01/03/2018 to 30/04/2018 is 5,319 tCO_2e.

Hence, $BE_{CH4,y}$ = 5,319 tCO_2e (worksheet Monthly calculations column AN and AO)

Please refer ER sheet for calculation details.

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

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

Where,

$BE_{EC,y}$	Baseline emissions from electricity consumption in year *y* (tCO2/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* (tCO2/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

The net electricity exported to the grid during current monitoring period i.e. 12/03/2015 to 30/04/2018 is 13,650.26 MWh. The baseline emission due to electricity is calculated as below

$EC_{BL,k,y}$ =13650.26 MWh, monitored value
$FEEL_{,k,y}$ = 0.4 tCO_2/MWh, as per registered PDD
$TDL_{k,y}$ = 20%, default as per applied methodology)

$BE_{EC,y}$ = 13650.26 * 0.4 (1+20%) = 6,552.12 tCO_2e

The value calculated in ER sheet as yearly with round down is 6,550 tCO_2e as a conservative approach.

Hence, $BE_{EC,y}$ = 6,550 tCO_2e

Total baseline emissions, BE_y= $BE_{CH4,y}$ + $BE_{EC,y}$ = 5,319 + 6,550 = 11,869 tCO_2e

E.2. Calculation of project emissions or actual net removals

>>

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

Where,

PE_y	Project emissions in year *y* (t CO2/yr)
$PE_{EC,y}$	Emissions from consumption of electricity due to the project activity in year *y* (t CO2/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 CO2/yr)

No project emissions from the project activity, as energy consumption that is utilized from grid, in the event gas engine not working and flares need to run, is accounted as import from the grid is included as monitored parameter. The baseline emissions from electricity is calculated on net electricity exported to grid, hence no project emission due to import of electricity is calculated, which is appropriate.

There is captive DG set as a backup for the project activity, however the same was not operated during current monitoring period and hence no fossil fuel consumption.

Hence,
PE_y = 0 tCO_2

E.3. Calculation of leakage emissions

>>
No leakage effects are accounted for under this methodology, hence

$LE_y = 0\ tCO_2$

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	11,869	0	0	-	11,869	11,869

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the PDD (t CO_2e)
11,869	365,759

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

>>
The ex-ante emission reduction estimated in PDD i.e. 116,494 tCO_2e/year based on estimated annual electricity generation and methane destruction/avoidance. The value is calculated for number of days current this monitoring period i.e. 1146 days, the value comes as 365,759 tCO2e.
The annual estimated CER as per registered PDD = 116,494 tCO_2e/year
The corresponding CERs during current monitoring period = (116,494 x 1146)/365.
The corresponding CERs during current monitoring period = 365,759 tCO_2e

E.6. Remarks on increase in achieved emission reductions

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The actual ERs are 96.8% lower than estimated ER for the comparable period in registered PDD.

E.7. Remarks on scale of small-scale project activity

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Not applicable as project activity is large scale project.

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Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • Ensure consistency with version 01.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).

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