



**Verified Carbon
Standard**

ENERGY JOBURG MONITORING REPORT



Document Prepared by David Cornish

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Prepared By	David Cornish
Contact	Address: Unit 2, The Firs, 5 Humber Street, Woodmead, Johannesburg, South Africa; Telephone: 0027-(0)11 803 8245; email: dcornish@gessa.co.za.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Joburg Landfill Gas to Energy Project (the "Project") developed by Energy Joburg RF (Pty) Ltd. (the "Project developer") is a landfill gas (hereafter, "LFG") collection and utilisation project at the Johannesburg landfill sites located in Johannesburg, South Africa (the "Host Country").

The objective of the project is to collect and destroy/utilise the LFG generated at five Johannesburg landfill sites. The project activity consists of two distinct stages:

1. LFG is captured and destroyed by using a LFG flare. The purpose of LFG flaring is to dispose of the flammable constituents, particularly methane, safely, and to control odour nuisance, health risks, and adverse environmental impacts. Hence, investment will be made in a highly efficient gas collection system and flaring equipment.
2. The captured LFG will be fed to the LFG flare and modular electricity generation plants. The generators will combust the LFG methane to produce electricity for internal use and/or export to a local power purchaser. Excess LFG and all gas collected during periods when electricity is not produced, will be flared.

Prior to implementation of the project activity, the LFG was being freely emitted into the atmosphere resulting in GHG emissions. The Project involves the destruction/utilisation of methane emissions as well as the displacement of electricity from the South African coal-based grid, resulting in a consequent reduction in CO₂ emissions. In the baseline scenario, the LFG would have been released into the atmosphere resulting in GHG (CH₄) emissions to the atmosphere. The electricity would have been produced in the fossil fuel based South African grid resulting in CO₂ emissions.

Emission reductions are produced by the capture and destruction/utilisation of LFG and the displacement of coal-based electricity from the grid by the generation of electricity from captured LFG. The annual average and total GHG emission reductions for the second crediting period is 480 155 tCO₂e and total of 361 087 tCO₂e respectively and a total GHG emission reduction of 275 155 for this monitoring period. The project includes five sites. The Robinson Deep flare was commissioned on 27 May 2011 and electricity generation was commissioned on 26 November 2016. The Marie Louise landfill site flare was commissioned on 04 May 2012 and electricity generation was commissioned on 25 January 2018. The Goudkoppies flare and electricity generation components were commissioned on 25 April 2017. The last two sites, namely Linbro Park and Ennerdale sites, are currently not constructed and will remain within the basket to projects, subject to economic drivers required to commit to build these sites.

1.2 Sectoral Scope and Project Type

Sectoral Scope 13 - Waste Handling and Disposal

Conditional sectoral scope 1 - Energy industries (renewable - / non-renewable sources)

The project is not a grouped project but rather a basket of five separate sites under one basket project registration with multiple project activity instances. There is no intention to add any additional sites outside of the ones listed above.

1.3 Project Proponent

Organization name	ENERGY Joburg RF (PTY) Limited
Contact person	David Cornish
Title	Director
Address	Unit 2, The Firs, 5 Humber Street, Woodmead, Johannesburg, South Africa.
Telephone	+27 118038245
Email	dcornish@gessa.co.za

1.4 Other Entities Involved in the Project

No other entities are involved in the Project.

1.5 Project Start Date

The project start date is the 27 May 2011 (VERRA start date) and this is the date of the commissioning certificate issued supplier for the first plant started at Robinson Deep.

1.6 Project Crediting Period

The first crediting period commenced on the 27 May 2011 with Verra for pre-registration VERs and on 12-11-2012 under the CDM registration with the UNFCCC with a seven year crediting period. The second 7 year crediting period has been renewed under CDM and was approved and starts on the 12-11-2019. We will however be applying for a renewal under VERRA for a second 10 year term from the 27May 2021 to 26 May 2031.

1.7 Project Location

The project activity sites are located in Johannesburg, in the Gauteng Province of South Africa.

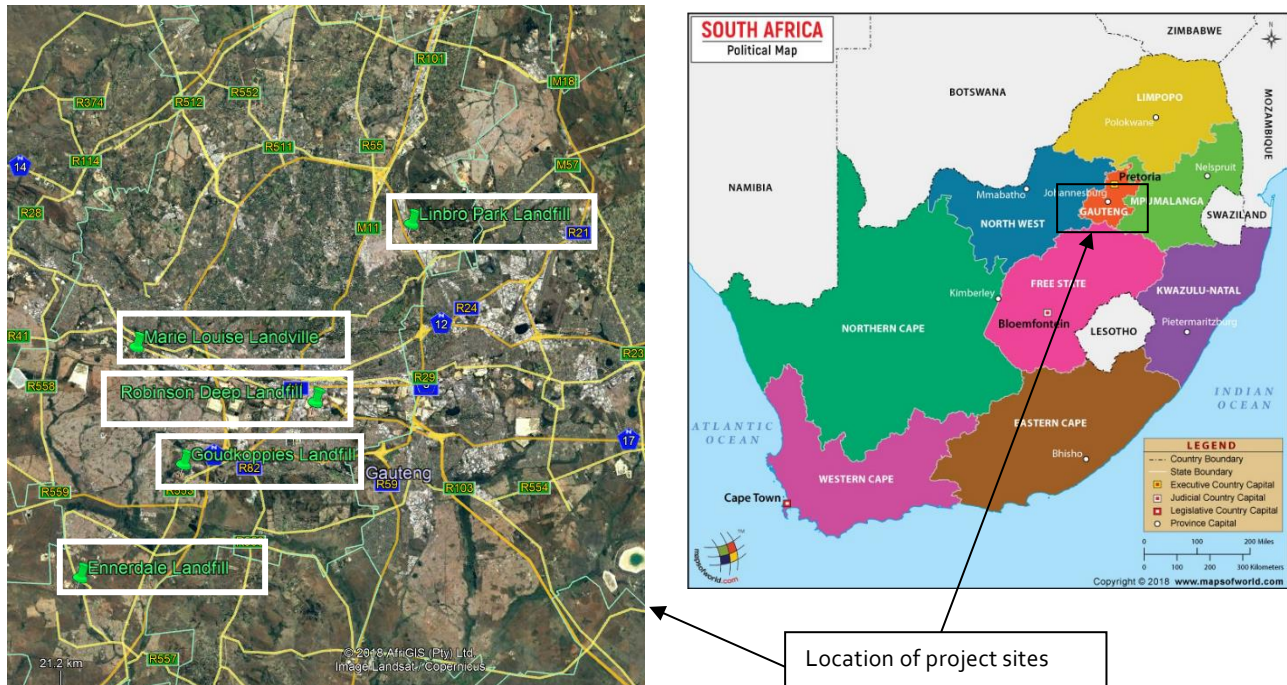


Figure: Locations of the project activity sites

The project activity sites are located at the following addresses and co-ordinates:

- i. Linbro Park Landfill - Marlboro Drive, Sandton: 26° 05' 41.85" S & 28° 07' 13.43" E;
- ii. Marie Louise Landfill - Dobsonville Drive, Roodepoort: 26° 11' 23.89" S & 27° 53' 00.13" E;
- iii. Robinson Deep Landfill – Turffontein Road, Turffontein: 26° 13' 59.03" S & 28° 02' 14.77" E;
- iv. Goudkoppies – Houthammer Road, Devland, Lenasia: 26° 16' 52.31" S & 27° 55' 24.93" E; and
- v. Ennerdale Landfill – Old Lawley Road, Lawley: 26° 22' 07.78" S & 27° 50' 02.80" E.

1.8 Title and Reference of Methodology

The large scale methodology ACM0001 Version 19, adopted at EB47, "Large-scale Consolidated Methodology Flaring or use of landfill gas" has been used in the project activity.

Furthermore, the project makes use of the following tools, which are referred to in ACM0001, ver. 19:

- TOOL02 "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0) (hereafter also referred to as "Additionality tool").
- TOOL03 "Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion" (Version 03.0).
- TOOL04 "Emissions from solid waste disposal sites" (Version 08.0).

- TOOLo5 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version o3.o).
- TOOLo6 "Project emissions from flaring" (Version o3.o).
- TOOLo8 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version o3.o):
- TOOL11 "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version o3.o.1).
- Standardized Baseline: Grid emission factor for the Southern Africa power pool (ASBoo4o-2018, Version o1.o).

1.9 Participation under other GHG Programs

The project is also registered with the UNFCCC with registration number 6797.

The project has had the following issuances through the registration with the UNFCCC:

12 November 2012 to 30 April 2013	27 832 CERs requested
1 May 2013 to 31 August 2014	88 454 CERs requested
1 September 2014 to 31 March 2018	211 213 CERs requested
1 April 2018 to 11 November 2019	268 297 CERs requested

Requested means the total requested prior to deduction of SOP volumes.

1.10 Other Forms of Credit

The Project does not engage in any other environmental crediting activities.

1.11 Sustainable Development Contributions

No new project activities were implemented during this monitoring period.

The project activity uses landfill gas for electricity generation. The SD contributions address Goal 13 "Take urgent action to combat climate change and its impacts" but more specifically 13.2.1 and the project contributes to the reduction of greenhouse gases. The project also addresses goal 7.2 by increasing renewable energy in the energy mix for South Africa. The emission reduction is monitored and reported to UNFCCC or VCS and electrical energy is metered and reported to the Independent Power Producers Office in South Africa in terms of the REIPPP (Renewable energy independent Power Producers Procurement Programme) which is a programme implemented by the South African government to stimulate renewable energy in the energy mix.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	The project has through the continued collection and utilization of landfill gas reduced the greenhouse gas emissions for this monitoring period by 257 078 tons of Co2e.	The project has decreased greenhouse gas emissions by a total of 852 874 over the project lifetime.
2)	7.2	By 2030, increase substantially the share of renewable energy in the global energy mix	Implemented activities to increase renewable energy in the energy mix	No further changes in this monitoring period and total contribution of 38 726.2MWh	The project increased the electricity production from landfill gas by 7MW of installed capacity as part of the renewable energy capacity under the REIPPP program.

2 SAFEGUARDS

2.1 No Net Harm

As the project removes the greenhouse gas and is established on an existing operational landfill site there are no negative impacts from the project activity that we are aware of that are not already monitored such as the diesel consumption.

2.2 Local Stakeholder Consultation

WSP Environmental South Africa (Pty) Ltd. was appointed by ENERGY Joburg RF (Pty) Ltd to carry out the environmental scoping, Environmental Impact Assessment (EIA), and draft Environmental Management Plan (EMP), for the development of the Joburg Landfill Gas to Energy Project into a CDM Project. The scoping report and the stakeholder consultation clearly specify that the project is designed under the CDM.

WSP has undertaken the Public Participation Process (PPP) according to the requirements of the NEMA EIA regulations stipulated in Chapter 6 (Section 56 to 59) of R. 385. The PPP ensures transparency of the project and provides an open channel of communication between the authorities, the public, and the project team. WSP undertook the PPP through the use of site notices, Background Information Documents (BID's), and the media in the form of advertisements. Public Meetings were held during the week 23 – 27 February 2009. An Authorities Meeting was held on the 27 February 2009 at WSP's main boardroom. As a result, a general Issues Trail for each site has been developed and formed part of the final EIA and EMP Report. All reports went on public review for a period of four weeks initially, from 7 August until 4 September 2009. The public review period for the EIA and EMP Reports were extended due to delays from DEAT for an additional three weeks.

The objectives of the PPP are as follows:

To ensure an open and transparent EIA and consultation process;

To identify and inform I&APs of the proposed project and associated EIA process;

Establish communication between the I&APs and WSP;

Provide an opportunity for I&APs to raise their issues, concerns and questions and ensure that these are considered in the EIA process;

Ensure that I&APs have an opportunity to make a meaningful contribution towards decision making by the lead authority; and

Develop an Issues Trail of all issues, concerns, and questions raised during the PPP and other I&AP consultation processes.

In addition to the above Interested & Affected Parties (I&APs) were identified by placing official notices of the EIA process for the proposed development in the national newspaper, "The Citizen" on 19/02/2009. In addition advertisements were placed in "The Citizen" and "The Sowetan" newspapers on the 07/08/2009. The reports went on public review for a period of four weeks from 07/08/2009 to 04/09/2009 at appropriate public venues in the areas of the landfills. After this public consultation meetings were held to get feedback from the public on the proposed project activity and this was conducted by WSP as a specialist consultant and registered public consultant practitioner. Notes of each I&AP and comments from I&AP's were compiled and recorded and made available to the authorities as part of the approval process.

The project is operated under contract by ENERGY Joburg on the City Of Joburg landfill sites and as such ENERGY Joburg engages with the City Of Joburg through steering committee meetings in which the performance of the project is monitored as well as how gas field works are discussed and agreed to for new section of waste. This partnership between the project and the City in which the ongoing performance and expansion of the sites and how to be utilize the space and ensure gas collection for the tipped waste. Included in the contract obligation with the city is make adjustment to the gas collection system if there are complaints from the public with regards to odours from the landfill site. To date since the projects have been operational no such complaints have been received and as a result no changes have been tabled by the city that there has been no need for the project design to be updated.

In addition to the above ENERGY Joburg engages in an active social economic development programme with the local community. This is evidenced by the our Economic Development plan and reflected in the ENERGY Joburg SED projects reports which shows pictures of the various projects undertaken to put something back into the communities in which these projects operate. This process involved undertaking a needs assessment every three months in which we identify a local underprivileged schools and asses the needs at these schools and then we embark on a programme of addressing the most urgent needs and work with the school unit is up to the same standard as other well-funded schools.

2.3 AFOLU-Specific Safeguards

Not applicable to this project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project includes five landfill sites. The Robinson Deep flare was commissioned on 27 May 2011 and electricity generation was commissioned on 26 November 2016. The Marie Louise landfill site flare was commissioned on 04 May 2012 and electricity generation was commissioned on 25 January 2018. The Goudkoppies flare and electricity generation components were commissioned on 25 April 2017. The last two sites, namely Linbro Park and Ennerdale sites, are currently not constructed and will remain within the basket of projects, subject to economic drivers required to commit to build these sites.

3.2 Deviations

3.2.1 Methodology Deviations

This is not applicable as there have been no deviation for the methodology during this monitoring period.

3.2.2 Project Description Deviations

First deviation.

There is a project description deviation with use of the 10 year crediting term under VERRA as the first crediting period starts on 27 May 2011 under the VCS PD for pre-registration VERs. The first crediting period starts on 12 November 2012 under the CDM with a seven-year crediting period twice renewable. The second 7-year crediting period has been renewed under CDM and was approved and starts on 12 November 2019. We will however be applying for renewal under VERRA for a second 10-year term from the 27 May 2021 to 26 May 2031. This makes that the first VCS crediting period is 10 years twice renewable from 27 May 2011 to 26 May 2021.

We have updated the project from the methodology originally registered with VERRA in so far as the project has renewed the PDD with the UNFCCC and used the latest version of the methodology. This is effectively a change from ACM001 V11 to ACM0001 V19 and with the use of ASB0040-2018 Standardized baseline: Grid emission factor for Southern African Power Pool,

version 1. This PDD was approved along with the second crediting period by the UNFCCC on the 23 February 2021.

With reference to the above two paragraphs there is no impact on the applicability of the methodology as this is a common methodology between VERRA and CDM and the application of the additionality requirements including the baseline scenarios have been applied tested during the crediting period renewal audit.

Second Deviation.

In addition to the above there are two deviations to the project description document and they are both due to delays in calibration of an instrument, one for the parameter $FC_{i,j,y}$, and the other for parameter Mt_{wb} . The values were adjusted up or down by the greater of the actual deviation and or the error, whichever is the lesser or greater value in order to be conservative. The extent of the delay and applied error corrections are detailed in section 4.2 for the applicable parameter.

With regards to the above deviations we have applied a conservative principle to both parameters and this does not impact on the applicability of the methodology nor does it impact on any of the additionality aspects and or the baselines applied to the project.

3.3 Grouped Projects

This is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	GWPC _{CH₄}
Data unit	tCO _{2e} /tCH ₄
Description	Global Warming Potential of methane
Source of data	IPCC (Fourth Assessment Report)
Value applied	25 up to the 31-December-2020 and 28 from 01-January-2021.
Justification of choice of data or description of measurement	In line with values adopted in VCS Standard V4.2 Up to 1 st January 2021 GWP CH ₄ 25 value from IPCC AR ₄

methods and procedures applied	From 1 st January 2021 onwards GWP CH ₄ 28 value from IPCC AR5 .
Purpose of Data	Calculation of baseline emissions or baseline net GHG removals by sinks
Comments	This parameter is in line with the values adopted by decision 4/CMP.

Data / Parameter	EFEL or EFgrid, CM, y																	
Data unit	tCO2/MWh																	
Description	Combined margin emission factor for the grid in year y																	
Source of data	Standardized baseline "Grid emission factor for the Southern African power pool", version 01.0.																	
Value applied	0.9091																	
Justification of choice of data or description of measurement methods and procedures applied	<table><tr><th rowspan="2">Parameter</th><th rowspan="2">Unit</th><th rowspan="2">Description</th><th rowspan="2">Applicable project types</th><th colspan="3">Applicable values</th></tr><tr><th>First crediting period</th><th>Second crediting period</th><th>Third crediting period</th></tr><tr><td>EF_{grid, CM, y}</td><td>tCO₂/MWh</td><td>Combined margin CO₂ emission factor for interconnected electricity system of the SAPP</td><td>All project activities except wind and solar power generation</td><td>0.9481</td><td>0.9091</td><td>0.9091</td></tr></table>	Parameter	Unit	Description	Applicable project types	Applicable values			First crediting period	Second crediting period	Third crediting period	EF _{grid, CM, y}	tCO ₂ /MWh	Combined margin CO ₂ emission factor for interconnected electricity system of the SAPP	All project activities except wind and solar power generation	0.9481	0.9091	0.9091
Parameter	Unit					Description	Applicable project types	Applicable values										
		First crediting period	Second crediting period	Third crediting period														
EF _{grid, CM, y}	tCO ₂ /MWh	Combined margin CO ₂ emission factor for interconnected electricity system of the SAPP	All project activities except wind and solar power generation	0.9481	0.9091	0.9091												
Purpose of Data	Calculation of baseline emissions																	
Comments	None																	

Data / Parameter	Φdefault
Data unit	-
Description	Model correction factor to account for model uncertainties
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value applied	0.75
Justification of choice of data or description of measurement methods and procedures applied	Application A is as the project activity mitigates methane emissions from existing SWDSs in Gauteng. The sites are therefore dry sites
Purpose of Data	Calculation of baseline emissions

Comments	None
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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, Version 08.0
Value applied	0.1
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Default value from the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" Version 8.
Purpose of Data	Calculation of baseline emissions
Comments	None

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 applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Default value as defined in the " <i>Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site</i> " Version 8.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	MCF _{default}
Data unit	-
Description	Methane Correction Factor
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value applied	1.0
Justification of choice of data or description of measurement methods and procedures applied	1.0 for anaerobic managed solid waste disposal sites. Default value as defined in the " <i>Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site</i> ", Version 8 (for a site with controlled placement of waste, cover material, and levelling of the waste) was used.
Purpose of Data	Calculation of baseline emissions
Comments	The methane correction factor (MCF) accounts for the fact that unmanaged SWDSs produce less methane from a given amount of waste than managed SWDSs, since a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDSs.

Data / Parameter	DOC _j
Data unit	-
Description	Fraction of degradable organic carbon in the waste type j.
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0

Value applied	The following values for the different waste types j are applied:	
	Wood and wood products	43
	Pulp, paper and cardboard (other than sludge)	40
	Food, food waste, beverages and tobacco (other than sludge)	15
	Textiles	24
	Garden, yard and park waste	20
	Glass, plastic, metal, other inert waste	0
Justification of choice of data or description of measurement methods and procedures applied	In accordance with the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", Version 8.	
Purpose of Data	Calculation of baseline emissions	
Comments	The values applied are for wet waste.	

Data / Parameter	kj
Data unit	-
Description	Decay rate for the waste type j
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0

Value applied	Waste type <i>j</i>		Boreal and Temperate (MAT≤20°C)		Tropical (MAT>20°C)	
			Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP<1000mm)	Wet (MAP>1000mm)
	Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
		Wood, wood products and straw	0.02	0.03	0.025	0.035
	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40
Justification of choice of data or description of measurement methods and procedures applied	As per the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site, version 8”.					
Purpose of Data	Calculation of baseline emissions					
Comments	The values applied are for Boreal & temperate (MAT < 20°C) and dry (MAP < 1,000mm) conditions. Proof of the climate data for Johannesburg from the South African Weather Service will be provided to the DOE upon request					

Data / Parameter	f_y
Data unit	-

Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	Methodological tool: Emissions from solid waste disposal sites, Version 08.0
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	In accordance with paragraph 38(a) of the applied methodology, ' 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'.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	W_x
Data unit	Tonnes
Description	Amount of solid waste type j disposed in the SWDS in year x
Source of data	Landfill Operator
Value applied	Ex ante data provided at validation
Justification of choice of data or description of measurement methods and procedures applied	Data is taken from historical records of landfill operation and aggregated annually.
Purpose of Data	Calculation of baseline emissions
Comments	This is determined once ex-ante for the purpose of estimating emission reductions.

Data / Parameter	$NCV_{i,y}$
Data unit	GJ per mass or volume unit (e.g. GJ/m ³ , GJ/ton)
Description	Weighted average net calorific value of fuel type i in the year y
Source of data	IPCC default values as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value applied	0.0433 TJ/t

Justification of choice of data or description of measurement methods and procedures applied	This parameter will only be used if and when there is fossil fuel consumption. Fossil fuel consumption will be monitored as stated in Section B.7.1.
Purpose of Data	Calculation of project emissions.
Comments	None

Data / Parameter	$EF_{CO_2,i,y}$
Data unit	tCO ₂ /GJ
Description	Weighted average CO ₂ emission factor of fuel type <i>i</i> in the year <i>y</i>
Source of data	IPCC default values as provided in Table 1.4 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.
Value applied	74.8 tCO ₂ /TJ
Justification of choice of data or description of measurement methods and procedures applied	Values are taken from IPCC (2006) for diesel ¹ . Any future revision of IPCC guidelines will be taken into account at the renewal of the crediting period.
Purpose of Data	Calculation of project emissions
Comments	This parameter will <i>only</i> be used if and when there is fossil fuel consumption. Fossil fuel consumption will be monitored as stated in Section B.7.1.

Data / Parameter	η_{PJ}
Data unit	-
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	ACM0001 version 19

¹ This is used for illustrative reasons for ex-ante estimations, as the fossil fuel used in the project activity may be subject to change. Thus the actual $EF_{CO_2,i,y}$ from the fuel consumed shall be used for ex-post ER calculations.

Value applied	0.5
Justification of choice of data or description of measurement methods and procedures applied	Since the technical specifications are not available for the LFG capture system, a default value of 50% is applied for the purposes of ex-ante emissions estimation.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	SPEC _{flare}			
Data unit	Temperature (°C) Flow rate or heat flux (kg/h or m ³ /h) Maintenance schedule (N° of days)			
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule.			
Source of data	Flare Manufacturer			
Value applied		Temperature (°C)	Flow rate m ³ /h	Maintenance schedule
	Min	700°C	400m ³ /h	Not applicable.
	Max	1,200°C	2,000m ³ /h	The maintenance schedule is not required if Option A (default flare efficiency option specified in the tool titled 'Project emissions from flaring, v3') is selected to determine flare efficiency of an enclosed flare

Justification of choice of data or description of measurement methods and procedures applied	The values were taken from the specifications provided by the flare manufacturer. These specifications stipulate the operating ranges for temperature and flow rate.
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	Ru
Data unit	Pa.m ³ /kmol.k
Description	Universal ideal gases constant
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value applied	8.314
Justification of choice of data or description of measurement methods and procedures applied	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	MM_i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas <i>i</i>
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value applied	Methane: 16.04 Nitrogen: 28.01
Justification of choice of data or description of measurement	"The molecular mass of Methane is 16.04 kg/kmol as per the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0

methods and procedures applied	
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	P_n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value applied	101,325 Pa
Justification of choice of data or description of measurement methods and procedures applied	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	T_n
Data unit	K
Description	Temperature at normal conditions
Source of data	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Value applied	273.15 K
Justification of choice of data or description of measurement methods and procedures applied	"Tool to determine the mass flow of a greenhouse gas in a gaseous stream", Version 03.0
Purpose of Data	Calculation of baseline emissions
Comments	None

Data / Parameter	$\eta_{\text{flare},m}$
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Data unit	-
Description	Flare efficiency for the minute m
Source of data	Methodological Tool "Project emissions from flaring" Version 02.0.0
Value applied	0.8
Justification of choice of data or description of measurement methods and procedures applied	The flare efficiency for the minute m is 80% when the following two conditions are met to demonstrate that the low-height flare is operating: 1. The temperature of the flare (TEG_m) and the flow rate of the residual gas to the flare (FRG_m) is within the manufacturer's specification for the flare (SPEC_{flare}) in minute m; and 2. The flame is detected in minute m (Flam_m). Otherwise $\eta_{\text{flare},m}$ is 0%.
Purpose of Data	Calculation of baseline emissions
Comments	In accordance with paragraph 23 of the tool "Project emissions from flaring" Version 02.0.0. The applied efficiency has been adjusted to 80% from the default of 90% as the flares are defined as low height flares.

4.2 Data and Parameters Monitored

Data / Parameter	Management of SWDS
Data unit	-
Description	Management of SWDS
Source of data	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local or national regulations.
Description of measurement methods and procedures to be applied	Waste Management Licenses: - Ennerdale Landfill: 12/9/11/L53/3 - Goudkoppies Landfill: 12/9/11/L283/3 - Linbro Park Landfill: 12/9/11/L282/3 - Marie Louise Landfill: 12/9/11/L280/3 - Robinson Deep Landfill: 12/9/11/L281/3
Frequency of monitoring/recording	Annual

Value monitored	Annual
Monitoring equipment	The waste management license is granted by a governmental department (3 rd party)
QA/QC procedures to be applied	The waste management license is granted by a governmental department (3 rd party)
Purpose of the data	Calculation of baseline emissions
Calculation method	None
Comments	None

Data / Parameter	Op _{j,h}
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Description of measurement methods and procedures to be applied	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 three parameters: - The operating temperature of the flare will be measured using a thermocouple located within the combustion chamber of the flare. The minimum operating temperature is 700°C and the maximum operating temperature is 1200°C; - A UV sensor will be located in the combustion chamber and used to detect a flame; - Products generated: electricity generated. 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); - No products are generated in the hour h Otherwise, Op_{j,h}=1

Frequency of monitoring/recording	Hourly
Value monitored	N/A
Monitoring equipment	Flare program logic controller
QA/QC procedures to be applied	-
Purpose of the data	Calculation of baseline emissions
Calculation method	Calculated in the workbook using a formula that checks the flow from the flow meters against the flare temperature and UV sensor and or electricity flow meter.
Comments	None

Data / Parameter	EGPJ,y								
Data unit	MWh								
Description	Amount of electricity generated using LFG by the project activity in year y								
Source of data	Electricity meter								
Description of measurement methods and procedures to be applied	Monitor net electricity generation by the project activity using LFG								
Frequency of monitoring/recording	Continuous								
Value monitored	<table> <tr> <td>Robinson Deep</td><td>24082.2 MWh</td></tr> <tr> <td>Marie Louise</td><td>7922.7 MWh</td></tr> <tr> <td>Goudkoppies</td><td>6721.3 MWh</td></tr> <tr> <td>Total</td><td>38726.2 MWh</td></tr> </table>	Robinson Deep	24082.2 MWh	Marie Louise	7922.7 MWh	Goudkoppies	6721.3 MWh	Total	38726.2 MWh
Robinson Deep	24082.2 MWh								
Marie Louise	7922.7 MWh								
Goudkoppies	6721.3 MWh								
Total	38726.2 MWh								
Monitoring equipment	Robinson Deep Name/description: Main Meter Manufacturer: Elster								

	Device type: A1700 Serial/model number: 351421105891 Class: 0.20 Validity: 01/03/2016 to 28/02/2026
	Marie Louise Name/description: Main Meter Manufacturer: Elster Device type: A1700 Serial/model number: 3514 21100020 Class: 0.50 Validity: 25/01/2016 to 24/01/2026
	Goudkoppies New Meter replaced on 01/02/2019 Name/description: Main Meter Manufacturer: Elster Device type: A1700 Serial/model number: 3514 41128474 Class: 0.50 Validity: 12/06/2018 to 11/06/2028
QA/QC procedures to be applied	Electricity meter(s) will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier, to ensure accuracy.
Purpose of the data	Calculation of baseline emissions
Calculation method	<i>Not applicable</i>
Comments	<i>None</i>

Data / Parameter	TDL _y
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity
Source of data	Eskom Annual Reports 2019, 2020 and 2021
Description of measurement methods and procedures to be applied	Monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Frequency of monitoring/recording	<i>Annual</i>
Value monitored	Insert TDL from reports 2019 9.71 2020 9.89 2021 11.78
Monitoring equipment	<i>N/A: Third party information source</i>
QA/QC procedures to be applied	<i>N/A: Third party information source</i>
Purpose of the data	<i>Calculate baseline emissions</i>
Calculation method	<i>Not Applicable</i>
Comments	<i>None</i>

Data / Parameter	TEG _m
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute <i>m</i>
Source of data	Project participants

Description of measurement methods and procedures to be applied	>500°C ²
Frequency of monitoring/recording	<i>Continuous monitoring of the temperature in the exhaust gas with a type N thermocouple.</i> <i>Accuracy of applied thermocouples: +/-0.75% (for 333°C to 1,200°C).</i>
Value monitored	Average Temperature Flare Robinson Deep 778,24 °C Average Temperature Flare Goudkoppies 771.85 °C Average Temperature Flare Marie Louise 810.38 °C
Monitoring equipment	Robinson Deep Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +/-0.75% (333°C-1200°C) Calibration: Functionality test at least annually Replaced 12/06/2018 Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +/-0.75% (333°C-1200°C) Calibration: Functionality test at least annually Replaced 11/03/2021 Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +/-0.75% (333°C-1200°C) Calibration: Functionality test at least annually

² This is an illustrative value used for the purposes of estimating emission reductions. Actual values used for the calculation of emission reductions will be monitored *ex-post*.

	Replaced 23/04/2021 Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +-0.75% (333°C-1200°C) Calibration: Functionality test at least annually Marie Louise Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +-0.75% (333°C-1200°C) Calibration: Functionality test at least annually Goudkoppies Type N thermocouple Serial No: Part Number T1TECNSX6o Accuracy: +-0.75% (333°C-1200°C) Calibration: Functionality test at least annually For all instruments: Accuracy: +-0.75% (333°C-1200°C) Calibration: Functionality test at least annually
QA/QC procedures to be applied	<i>The thermocouple will be subject to a functionality test against a calibrated instrument at least on an annual basis to ensure accuracy.</i> <i>The functionality tests were conducted on the following dates for each site</i>

*Marie Louise**T/CTEST**30/01/2020**29/04/2020**28/07/2020**28/10/2020**18/02/2021**19/05/2021**Goudkoppies**T/CTEST**22/01/2020**23/04/2020**22/07/2020**29/10/2020**04/02/2021**10/05/2021**24/08/2021**Robinson Deep**T/CTEST**27/01/2020**30/04/2020**29/07/2020**13/10/2020**15/01/2021*

	23/04/2021 14/07/2021
Purpose of the data	Calculate project emissions
Calculation method	Not Applicable
Comments	None

Data / Parameter	ECPJ,j,y
Data unit	MWh/y
Description	Quantity of electricity consumed by the project electricity consumption source in year y
Source of data	Project participants
Description of measurement methods and procedures to be applied	Electricity meter
Frequency of monitoring/recording	Continuous monitoring
Value monitored	Robinson Deep 664 MWh Goudkoppies 0 MWh Marie Louise 108 MWh Total 752 MWh
Monitoring equipment	Robinson Deep Part No: CBI- EC330CM Accuracy: class 1 Calibration: Calibration not required Solid state instrument Marie Louise

	Part No: DEM024SJ Accuracy: class B Calibration: Calibration not required solid state instrument Goudkoppies New Meter replaced on 01/02/2019 Name/description: Main Meter Manufacturer: Elster Device type: A1700 Serial/model number: 3514 41128474 Class: 0.50 Validity: 12/06/2018 to 11/06/2028
QA/QC procedures to be applied	<i>Electricity meters will be subject to regular maintenance and testing in accordance with stipulation of the meter supplier to ensure accuracy.</i>
Purpose of the data	<i>Calculate project emissions</i>
Calculation method	<i>Not Applicable</i>
Comments	<i>None</i>

Data / Parameter	$FC_{i,j,y}$
Data unit	Mass or volume unit per year (e.g. ton/yr or m ³ /yr)
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Description of measurement methods and procedures to be applied	Each fuel tank is fitted with a calibrated ruler used to measure the volume of fuel used. This is cross referenced with fuel procured to put into the tank.
Frequency of monitoring/recording	Continuously

Value monitored	Robinson Deep 166 Lt Marie Louise 170 Lt Goudkoppies 75 Lt Total 411 Lt
Monitoring equipment	<i>1st calibration 7/03/2019 for all three sites. The ruler does not state class or accuracy as the tanks and rulers were calibrated to stipulate the volumes from empty to full and provided a calibrated value for the ruler over the range of the ruler for the tank in question. The rulers will be calibrated annually.</i> • Robinson Deep: • Type: Volvo 105l (Diesel Tank level indicator) • Sl. No.: FE3095S • Marie Louise: • Type: Cummins 175l (Diesel Tank level indicator) • Sl. No.: AK16080689-A • Goudkoppies: • Type: Volvo 105l (Diesel Tank level indicator) • Sl. No.: FEO686S <i>Robinson Deep 105lt tank / +- 3lt accuracy = 2.9% (rounded up)</i> <i>Marie Louise 175lt tank / +-3lt accuracy = 1.8% (rounded up)</i> <i>Goudkoppies 105lt tank /+- 3lt accuracy = 2.9% (rounded up)</i> <i>2nd calibration on 22/04/2020</i> <i>As a result of the delay in calibration between the 07/03/2020 and the 22/04/2020 the values for this parameter were increased by the following percentages in order to be conservative.</i> <i>Robinson Deep 105lt tank / +- 3lt accuracy = 2.9% (rounded up)</i> <i>Marie Louise 175lt tank / +-3lt accuracy = 1.8% (rounded up)</i> <i>Goudkoppies 105lt tank /+- 3lt accuracy = 2.9% (rounded up)</i> <i>3rd calibration on 28/04/2021</i> <i>As a result of the delay in calibration between the 22/04/2021 and the 28/04/2021 the values for this parameter were increased by the following percentages in order to be conservative.</i> <i>Robinson Deep 105lt tank / +- 3lt accuracy = 2.9% (rounded up)</i> <i>Marie Louise 175lt tank / +-3lt accuracy = 1.8% (rounded up)</i>

	<i>Goudkoppies 105lt tank /+- 3lt accuracy =2.9% (rounded up)</i>
QA/QC procedures to be applied	Diesel will be supplied from tanks and ruler gauges will be used to determine volume of diesel consumed. The ruler gauges will be part of the tank and calibrated at least once a year. The measurements will be recorded in a book (on a daily basis or per shift). The volume is obtained by multiplying the tank level by the tank cross-sectional area. Calibration is undertaken once per year and have been provided.
Purpose of the data	Calculate project emissions
Calculation method	Not Applicable
Comments	None

Data / Parameter	$V_{i,t,wb}$
Data unit	m ³ gas i/m ³ wet gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a wet basis
Source of data	Measurement
Description of measurement methods and procedures to be applied	Continuous in-situ analyzers
Frequency of monitoring/recording	Measurements are logged once every minute
Value monitored	Robinson Deep 53.8% Marie Louise 48.6% Goudkoppies 53% Average 51.8 %
Monitoring equipment	Robinson Deep Flare ID: 10931 Edinburgh Instruments-Guardian NG Infrared Gas Monitor CH ₄ 0-100%

Accuracy: < 2% of full scale

Serial no: 10734

Calibration frequency: Monthly

1st calibration on 16/10/2017

The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced.

Replaced CH Sensor on 20/12/2019

CH₄ 0-100%

Accuracy: < 2% of full scale

Serial no: 14406

Calibration frequency: Monthly

1st calibration on 21/08/2018

The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced.

Replaced CH Sensor on 24/08/2021

CH₄ 0-100%

Accuracy: < 2% of full scale

Serial no: 17270

Calibration frequency: Monthly

1st calibration on 11/02/2020

The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced.

Marie Louise

Flare ID: 11104

Edinburgh Instruments-Guardian NG Infrared Gas Monitor

CH₄ 0-100%

Accuracy: < 2% of full scale

Serial no: 10733

	Calibration frequency: Monthly 1st calibration on 12/06/2018 The instrument is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced. Goudkoppies Siemens Ultramat 23 Serial Number: N1H3191 Maximum Drift: With AUTOCAL Negligible Repeatability/Accuracy: +-1% Calibration Frequency: 12 month using span gas. The instrument has an auto calibration function and such maintains its accuracy. It is calibrated regularly utilizing a certified span gas on site until the unit is no longer able to be calibrated on site. Should the instrument not be able to be calibrated then the instrument sensor is replaced. 1st calibration before shipping to site on 26 November 2016. The flaring plant was commissioned on the 15 February 2017 and facility began commercial operation on the 25/04/2017. 2nd calibration on 02/09/2019 3rd calibration on 19/10/2020 There was a delay in calibration between the 02/09/2020 and the 19/10/2020. For this 48 day period both dates included a reduction of 1% is applied.
QA/QC procedures to be applied	Calibration includes zero verification with an inert gas (e.g. O₂/N₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas CH₄ and CO₂). All calibration gases have a certificate provided by the manufacturer and must be under their validity period.

Purpose of the data	Calculation of Baseline Emissions
Calculation method	Not Applicable
Comments	None

Data / Parameter	$M_{t,wb}$
Data unit	kg/h
Description	Mass flow of the gaseous stream in time interval t on a wet basis
Source of data	Flow meter
Description of measurement methods and procedures to be applied	Continuous monitoring using the flow meter Instruments with recordable electronic signal (analogical or digital).
Frequency of monitoring/recording	Monitored continuously and recorded every one minute
Value monitored	Robinson Deep Average 1192 Kg/h Marie Louise Average 502 Kg/h Goudkoppies Average 444 Kg/h
Monitoring equipment	Total flow Meter For Robinson Deep Thermal Mass flow meters Type: E&H Proline T mass 65l Accuracy:<3% Calibration frequency: every three years as per manufacturer's specifications Serial No: C6031302000 1st calibration date 14/08/2017 Valid from 26/10/2017 to 25/10/2020 as per manufacturer's specifications. Replaced on 10/12/2020 (No spare on 25/10/2020 due to COVID delays) A reduction of 3% which is the great of the accuracy and actual deviation of the values for period has been applied to this parameter.

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: A309FB02000

1st calibration date 20/08/2020

Valid from 10/12/2020 to 09/12/2023 as per manufacturer's specifications

Total flow Meter

For Marie Louise

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E704B102000

1st calibration date 22/11/2017

Valid from 07/02/2018 to 06/02/2021 as per manufacturer's specifications

Replaced on 05/02/2021

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: L5003702000

1st calibration date 19/08/2020

Valid from 05/02/2021 to 04/02/2024 as per manufacturer's specifications

Total flow Meter

For Goudkoppies

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: N8103702000

1st calibration date 28/08/2018

Valid from 08/10/2019 to 07/10/2022 as per manufacturer's specifications

Flare flow meter

For Robinson Deep

Thermal Mass flow meters

Type : E&H Proline T mass 65l

Serial No: C905D602000

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications.

1st calibration date 19/06/2017

Valid from 12/07/2017 to 11/07/2020 as per manufacturer's specifications.

Replaced on 13/10/2020 (No spare on 11/07/2020 due to COVID)

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E2110D02000

1st calibration date 18/06/2020

Valid from 13/10/2020 to 12/10/2023 as per manufacturer's specifications

Flare flow meter

For Marie Louise

Thermal Mass flow meters

Type : E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E2110D02000

1st calibration date 15/01/2015

Valid from 14/12/2016 to 13/12/2019 as per manufacturer's specifications.

Replaced on 12/12/2019

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: A309F902000

1st calibration date 02/10/2019

Valid from 12/12/2019 to 11/12/2022 as per manufacturer's specifications

Flare flow meter

For Goudkoppies

Thermal Mass flow meters

Type : E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E2110B02000

1st calibration date 02/02/2018

Valid from 13/04/2018 to 12/04/2021 as per manufacturer's specifications

Replaced on the 12/04/2021

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E704AF02000

1st calibration date 17/06/2020

Valid from 12/04/2021 to 11/04/2024 as per manufacturer's specifications

Electricity Flow Meter

For Robinson Deep

Thermal Mass flow meters

Type : E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: C6031202000

1st calibration date 15/08/2017

Valid from 26/10/2017 to 25/10/2020 as per manufacturer's specifications

Replaced on the 17/03/2020

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: 99047602000

1st calibration date 16/05/2017

Valid from 17/03/2020 to 01/10/2020 as per manufacturer's specifications

Replaced on the 13/10/2020 (No spare on 01/10/2020 due to COVID)

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: A309FA02000

1st calibration date 19/08/2020

Valid from 13/10/2020 to 12/10/2023 as per manufacturer's specifications

Electricity Flow Meter

For Marie Louise

Thermal Mass flow meters

Type : E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: E704AF02000

1st calibration date 15/08/2017

Valid for 13/09/2017 to 12/09/2020 as per manufacturer's specifications.

Replaced on the 30/04/2019

Thermal Mass flow meters

Type: E&H Proline T mass 65l

Accuracy:<3%

Calibration frequency: every three years as per manufacturer's specifications

Serial No: N8103802000

1st calibration date 29/08/2018

Valid from 30/04/2019 to 29/04/2022 as per manufacturer's specifications

	Electricity Flow Meter For Goudkoppies Thermal Mass flow meters Type: E&H Proline T mass 65l Accuracy:<3% Calibration frequency: every three years as per manufacturer's specifications Serial No: E704B002000 1st calibration date 02/02/2018 Valid from 13/04/2018 to 12/04/2021 as per manufacturer's specifications Replaced on the 12/04/2021 Thermal Mass flow meters Type: E&H Proline T mass 65l Accuracy:<3% Calibration frequency: every three years as per manufacturer's specifications Serial No: C6031202000 1st calibration date 30/10/2020 Valid from 12/04/2021 to 11/04/2024 as per manufacturer's specifications Please note that manufacturer stipulates that although the instrument was calibrated on a certain date the validity of the calibration remains valid for the first three years of operation from the date of use and not the date of calibration.
	QA/QC procedures to be applied Periodic calibration against a primary device provided by an independent accredited
	Purpose of the data Calculation of baseline emissions
	Calculation method This parameter will be monitored in Option F as per the applied "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 02.0.0).
	Comments None
Data / Parameter	Flame_m

Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Flare program logic controller
Description of measurement methods and procedures to be applied	Measure using a fixed installation optical flame detector: Ultra Violet detector
Frequency of monitoring/recording	Continuous and recorded once every minute
Value monitored	Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
Monitoring equipment	The flares use a UV sensor to detect a flame when the flare is running Robinson Deep Tested Dates 27/01/2020 30/04/2020 29/07/2020 13/10/2020 15/01/2021 23/04/2021 14/07/2021 Marie Louise Tested Dates 30/01/2020 29/04/2020 28/07/2020 28/10/2020 18/02/2021

	19/05/2021
	Goudkoppies
	Tested Dates
	22/01/2020
	23/04/2020
	22/07/2020
	29/10/2020
	04/02/2021
	10/05/2021
QA/QC procedures to be applied	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of the data	Calculation of Project Emissions
Calculation method	-
Comments	None

4.3 Monitoring Plan

The Monitoring Plan for this project has been developed to ensure that from the start, the project is well organised in terms of the collection and archiving of complete and reliable data.

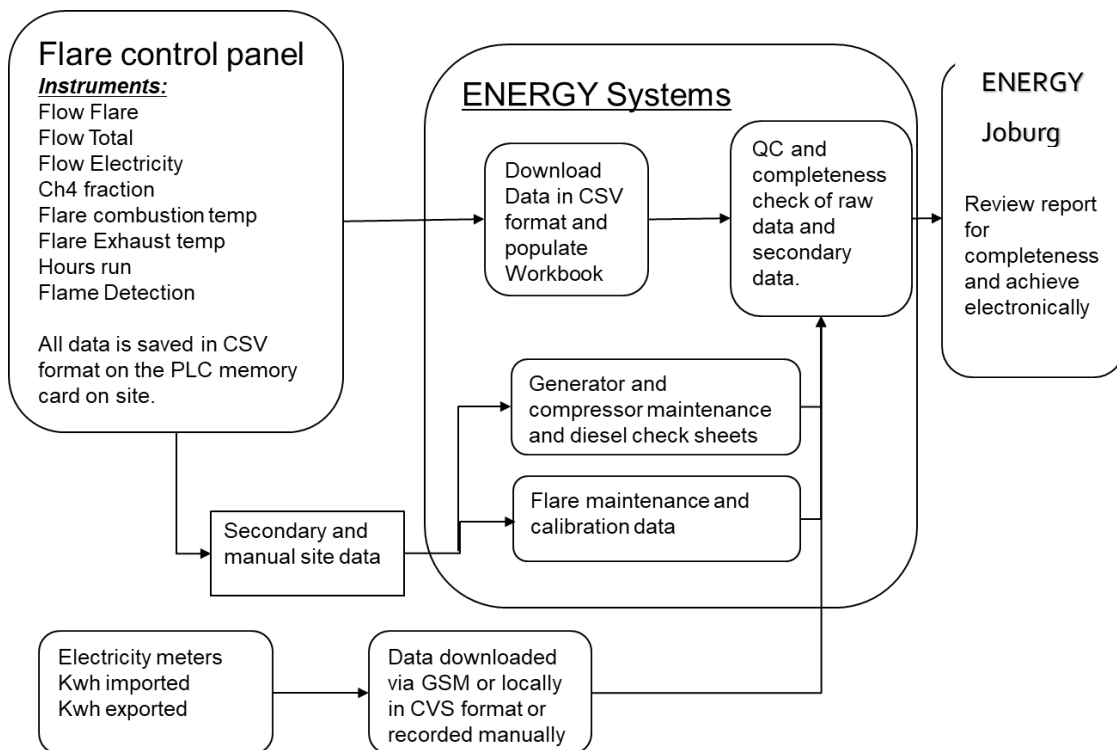
The monitoring system consists of total flow, flare flow and electricity flow meters that record the flow of landfill gas extracted from the site and conveyed to the flare and generators in Nm³/h. The landfill gas is then analysed by a fixed gas analyser that measures the concentration of methane in the landfill gas. The gas is then either combusted in a high temperature enclosed flare and the combustion temperature is monitored to ensure that the methane gas is combusted at a suitable temperature or the gas is used for power generation in the generators. All of the above measurements are recorded and stored in CSV (comma separated Values) format available for download.

The data is downloaded monthly and compiled into a workbook where the raw data is used to calculate the number of emission reductions achieved by applying the approved calculations as detailed in the PDD.

The monthly reports are then reviewed and checked for inconsistencies by comparing the data and the site trip sheets to establish if there are any mismatches in the data with that of the site records. This review and check is done every month and any queries regarding the quality of the data or outages are resolved through this check process and closed out before the report is finalised. This report and the final workbook is then stored electronically by the operations manager and or the general manager.

The workbooks only provide the electronic data for the methane destroyed by the projects activities. Other parameters are also recorded but are documented manually such as the projects emissions from fuel consumed or electricity consumed. This data is then included in the monitoring periods consolidated workbook that takes into account both emission reductions from the project activity and the project emissions and established the net reduction in tCO₂e.

Below is a diagrammatic flow chart showing the flow of data from each site for the project.



Quality assurance

The data is compiled into a monthly workbook which takes the collected data and calculates the volume of CERs produced from the project activity. This data is reviewed for consistency and details of the plants' operations over the month. This data and the trip sheets are used to compile a brief monthly report that documents the sites performance and plant availability but also highlights any challenges being faced by the project and or corrective action needed. Non-conformances are limited to delayed calibrations as the system is largely driven by electronic data capture. These are noted in the monitoring reports and instrument change out sheets and replacement calibration sheets.

Staff Training

ENERGY Joburg RF (PTY) Ltd embarks on continuous site based training that included induction training and CDM training when a new staff member joins the team and hands on technical training on a regular basis to enhance site based skills and knowledge. Training is very targeted and focussed on the individual areas of involvement, typically termed "On the Job Training" and is recorded in a sheet titled "Competency Records", and this is signed off by the trainer and trainee.

Position and Respective Person	Responsibilities	Authorities
ENERGY Systems Process Operations Manager (Tony Cummings – TC or other)	Overall responsibility for the landfill gas system. Overall responsibility for the Quality Management System for the landfill gas data collection system. Reviews performance data on landfill gas system Stores and archives data received for ENERGY Joburg RF (PTY) Ltd Robinson Deep, Goudkoppies and Marie Louise CDM projects.	Manages resources for operation of the landfill gas system
ENERGY Systems General Manager (David Cornish)	Overall responsibility for managing the projects and implementing the systems.	Manages resources for the system.

Position and Respective Person	Responsibilities	Authorities
ENERGY Joburg Site Technician (Elleck Mkhari – EM) (Erick Ramalebane _ER) and or other	Day-to-day operation of the landfill gas system and flare maintenance and calibration of site instruments.	Controls the landfill gas system and flare
Data Controller – David Cornish and or Tony Cummings	Reviews and compares primary data and secondary data from flare system. Prepares monthly workbook and submits to ENERGY Systems General Manager. Reviews comments.	Compile data into the monthly workbook.
PLC data logging	Responsible for data collection. Allows ENERGY Systems and access to down load the raw data collected from the sites.	Management and archiving of the raw data.

Emergency Procedures

A copy of our emergency procedures document for each of the sites has been provided which cover the procedure for shutting down the plant in the event of an emergency and reporting to an emergency evacuation point located on the site. The procedure further outlines the procedure for notifying the relevant line managers and site operators of the event and refers to the relevant incident report documents to be completed.

Sampling: Not applicable – sampling approach is not used.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The baseline emissions are determined according to equation (1) of the applied methodology:

$$BE_y = BE_{CH,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad (\text{Equation 1 of ACM0001, v19})$$

Where

$BE_{CH,y}$ Baseline emissions of methane from the SWDS ($BE_{CH4,y}$): value from below calculation 218 992

$BE_{EC,y}$ baseline emissions associated with electricity generation: value from below calculation 38 867.

$BE_{HG,y}$ there was no use of methane for heating: Value is 0.

$BE_{NG,y}$ there was no upgrading and use of methane for natural gas: Value is 0.

$$BE_y = 275\,936$$

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

Baseline emissions of methane from the SWDS are determined according to equation (2) of the applied methodology:

$$BE_{CH4} = \left((1 - OX_{toplayer}) \times F_{CH4,PJ,y} - F_{CH,BL,y} \right) \times GWP_{CH4} \quad (\text{Equation 2 of ACM0001, v19})$$

Where:

$OX_{toplayer}$ Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless), value 0.1

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH₄/yr). Values used 7322.6 up to 31 December 2020 and 2869.5 from 1 January 2021 to 26 May 2021.

$F_{CH,BL,y}$ Amount of methane in the LFG that would be flared in the baseline in year y (t CH₄/yr), the baseline value is 0.

GWP_{CH4} Global warming potential of CH₄ (t CO₂e/t CH₄) 25 for the period up to 31 December 2020 and 28 for the period from 1 January 2021 to end of monitoring period.

$F_{CH_4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution, as follows:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y} + F_{CH_4,HG,y} + F_{CH_4,NG,y}$$

(Equation 3 of ACM0001, v19)

Where:

$F_{CH_4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)
$F_{CH_4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year y (t CH ₄ /yr)
$F_{CH_4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in year y (t CH ₄ /yr)
$F_{CH_4,HG,y}$	Amount of methane in the LFG which is used for heat generation in year y (t CH ₄ /yr) this value is 0 as no methane was used for heating.
$F_{CH_4,NG,y}$	Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (t CH ₄ /yr) this value is 0 as no methane was upgraded and supplied as natural gas.

For:

$F_{CH_4,flared,y}$ in the workbooks take the flow to the flare per minute and adjusts it for the methane concentration and then multiplies it by the density for methane. This is then adjusted for the actual mass for that time interval to provide an actual unit and not a flow rate.

$F_{CH_4,EL,y}$ in the workbooks take the flow to the generators per minute and adjusts it for the methane concentration and then multiplies it by the density for methane. This is then adjusted for the actual mass for that time interval to provide an actual unit and not a flow rate.

The above calculation is contained in the individual site monthly workbooks and then consolidated workbook titled "Consolidated CDM ER Sheet 12 Nove to May 2021 V4" under the Baseline Emissions sheet.

The baseline emissions associated with electricity generation in year y ($BEE_{C,y}$) are calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 3”.

$BEE_{C,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$ (Equation 2 of Electricity Consumption and Generation Tool, v3). This case we are doing the calculation for Electricity generation:

Where:

$BEE_{C,y}$	Baseline emissions from electricity consumption in year y (t CO ₂ / yr)
$EC_{BL,k,y}$	Quantity of electricity that would be consumed by the baseline electricity consumer k in year y (MWh/yr). $EC_{BL,k,y}$ is equivalent to $EG_{PJ,y}$. In this case electricity generated is 3961 MWh for 2019, 23959 MWh for 2020 and 10806 MWh for 2021.
$EF_{EF,k,y}$	Emission factor for electricity generation for source k in year y (t CO ₂ /MWh) value 0.9091 t/MWh.
$TDL_{k,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y 9.71 in 2019, 9.89 in 2020 and 11.78 in 2021
k	Sources of electricity consumption in the baseline

The above calculation is contained in the consolidated workbook titled “Consolidated CDM ER Sheet 12 Nove to May 2021 V4” under the Baseline Emissions sheet.

5.2 Project Emissions

The project emissions are calculated in accordance with equation (22) of the applied methodology:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DY,y} \quad (\text{Equation 22 of ACM0001, v19})$$

Where:

PE_y = Project emissions in year y (tCO₂/y)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year y (tCO₂/y); value from below calculation 779

$PE_{FC,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, year y (tCO₂/y); value from below calculation 2

$PE_{DY,y}$ = Emissions from distribution of compressed/liquefied LFG using trucks in year y (tCO₂/y); this is 0 as no distribution of the gas took place in this monitoring period.

$$PE_y = 781$$

Project emissions from electricity consumption:

PEEC_y is calculated according to the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, Version 3” using the following equation:

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

(Equation 1 of Electricity Consumption Tool and Generation, v3)

Where:

EF_{EF,j,y} = Emission Factor for electricity consumed value applied is 0.9091 tCO₂/MWh for all periods

EC_{PJ,j,y} = Total electricity consumed 25 MWh in 2019, 273 MWh in 2020 and 474 MWh in 2021.

TDL_{j,y} = Transmission and Distribution losses; 9.71 in 2019, 9.89 in 2020 and 11.78 in 2021

$$PE_{EC,y} = 779$$

All of the above calculations are contained in the consolidated workbook titled “Consolidated CDM ER Sheet 12 Nove to May 2021 V4” under the Project Emissions sheet.

Project emissions from fossil fuel consumption:

$$PEFC_{j,y} = FCI_{j,y} \times COEF_{i,y}$$

Where

PEFC_{j,y} CO₂ emissions from fossil fuel combustion in process j during year

FCI_{j,y} Quantity of fuel type i combusted in process j during year y [Mass or volume unit/yr] is 0.35t;

COEF_{i,y} CO₂ emission coefficient of fuel type i in year y [tCO₂/mass or volume unit] is 3.24/t_il

$$PEFC_{j,y} = 2$$

$$COEF_{i,y} = NCV_{i,y} \times EFCO_{2,i,y}$$

Where

- COEF_{i,y} CO₂ emission coefficient of fuel type i in year y [tCO₂/mass or volume unit];
- NCV_{j,y} *Weighted average net calorific value of the fuel type i year y [GJ/mass or volume unit] is 0,0433 TJ/t;*
- EF_{i,j,y} Weighted average CO₂ emission factor of fuel type i in year y [tCO₂/TJ]
74.8tCO₂/TJ;
- i Fuel types combusted in process j during year y is standard diesel.

All of the above calculations are contained in the consolidated workbook titled “Consolidated CDM ER Sheet 12 Nove to May 2021 V4” .

5.3 Leakage

There are no leakage emissions associated with this project.

5.4 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
From 12 November 2019 Year 2019	24 296	24	0	24 272
Year 2020	168 349	273	0	168 076
Year 2021 up to 26 May 2021	83 291	483	0	82 808
Total	275 936	780	0	275 155

Note

2019 is for the period 12 November 2019 to 31 December 2019

2021 project emissions or removals is for the period from 1 January 2021 to 26 May 2021 only.

