



Avoidance of methane emission from Municipal Solid Waste project in Ethiopia

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Contents

Acronyms and abbreviations	3
1 Climate change mitigation programme or project (CCMP) information	4
1.1 CCMP holder information	4
1.2 Information from other CCMP institutional stakeholders.....	4
1.3 CCMP objective	4
1.4 CCMP description.....	5
1.4.1 Sectoral scope and type of CCMP	6
1.4.2 Location and limits of the CCMP	7
1.5 Holdership or right to use the area, facility, or process	10
1.6 Characteristics and conditions before the start of the CCMP	10
1.7 CCMP technologies, products, and services	12
9.7 m x 10.6 m	12
1.8 Chronological plan	16
2 Methodology	17
See section 2.1.....	17
2.1 Applicability of the selected methodology to the CCMP.....	17
The project activity is a MSW incineration power plant located at approximately seven to eight kilometers away from the Addis Ababa city center. The waste is converted into electricity by incineration process, all the energy produced is used by itself and excess will be sent to National Grid, so that the project is applicable to the conditions.	18
2.2 Additionality.....	26
2.3 No double counting.....	28
2.4 Baseline scenario	28
2.5 Project scenario	28
2.6 GHG emission sources.....	29
2.7 Methodological deviations	29
2.8 Accreditation period	29
3 Quantification of GHG emissions and GHG emission reductions	30
3.1 Quantification of GHG emissions in the baseline scenario.....	30
As per the applied methodology ACM0022, version 3.0, baseline emissions may comprise of the following sources:.....	30
A. Methane emissions from the SWDS in the absence of the project activity;	30
B. Methane emissions from the treatment of organic wastewater in the absence of the project activity;	30
C. Energy generated or electricity consumed by the grid in the absence of the project activity;	30
D. Natural gas used from the natural gas network in the absence of the project activity. .	30
3.2 Quantification of GHG emissions and reductions of GHG emissions in the project scenario	6
3.3 Leakage	14
3.4 Net GHG emission reductions.....	15
4 Legal and documentary aspects	17
4.1 Legal requirements	17

4.2	Link with NDCs	18
4.3	CCMP documentation	18
5	Stakeholder consultation	19
6	Safeguards	20
7	Uncertainty	21
8	Contributions to the United Nations Sustainable Development Goals	22
9	Grouped project	23
10	CCMP monitoring	24
10.1	Monitoring plan	24
10.2	Monitoring of GHG emissions in the baseline scenario.....	25
10.3	Monitoring of GHG emissions and GHG emission reductions in the project scenario.	32
11	Information management	46
12	References	47
13	Document history(PDD)	48
14	Template history	49

Acronyms and abbreviations

AACMA	Addis Ababa Cleansing Management Agency
AAWSA	Addis Ababa Water and Sewage Authority
CCMP	Climate Change Mitigation Programme or Project
CMO	Cleansing Management Office
EEP	Ethiopian Electric Power Corporation
EPA	Environmental Protection Authority
FDRE	Federal Democratic Republic of Ethiopia
GHG	Greenhouse Gases
HH	Household
ISWM	Integrated Solid Waste Management
JICA	Japan International Cooperation Agency
MSW	Municipal Solid Waste
NDCs	Nationally Determined Contribution
NGO	Non-governmental Organization
PDD	Project Description Document
SDG	Sustainable Development Goal
SME	Small and Medium-sized Enterprises
VVB	Validation and Verification Body
WtE	Waste to Energy

1 Climate change mitigation programme or project (CCMP) information

1.1 CCMP holder information

Full name(s)	Dr. Eng. Sultan Wali
Name of institution (if applicable)	Ministry of Water and Energy, Ethiopia
Roles or responsibilities	State Minister
Identification	FD1458614209146
Location	Addis Ababa
Telephone number(s)	+251- 116626325
E-mail address	ethiopia.carboncredits@gmail.com

1.2 Information from other CCMP institutional stakeholders

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Roles or responsibilities	CCMP Developer
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1.3 CCMP objective

The primary objective of the Municipal Solid Waste (MSW) treatment Project located in Addis Ababa; Ethiopia is to implement an advanced incineration process to manage municipal solid waste effectively. Addis Ababa, the capital of Ethiopia, has seen a significant population increase of one million over the 10 years since 2012, with the population reaching around 5.2 million by 2022. The amount of waste generation has also increased significantly, in line with the country's economic growth. Currently, the city generates an estimated 2,647 tons of waste per day, an amount that is expected to increase further. However, it has become quite difficult for the Addis Ababa Cleansing Management Agency (AACMA), a core administrative body, to handle the increasing volume of waste in an adequate manner. In addition, waste dumping has been causing adverse effects on the environment and the deterioration of public health. The Koshe landfill site is the only final disposal site in the city. It has been mostly used as an open dumping site and, in 2017, an accident occurred in which part of the landfill site collapsed as a result of waste that

had piled up in a disorderly manner. The site has been in use for more than 50 years, exceeding its service life, but there are no plans to construct a new landfill site¹.

The primary objective of the Reppie Waste-to-Energy Project (RWEPP) is the treatment of municipal solid wastes by use of innovative technology such as incineration, which avoids methane emissions from dumping of waste in open landfills. The start date of plant construction was 14th September 2014, which was completed on 19th August 2018. The starting date of receiving the MSW was 14th April 2019, and the startup of incinerator was on 1st May 2019. However 1st January 2020 is considered as the start date as the plant started generating the GHG ERs only after the pre-operation test period and commissioning. As per CERC definition of start date, the start of operation is understood as the moment the program or project activity starts generating climate change mitigation results due to the implementation of its actions, processes, or facilities in a certain place, at normal operation. Normal operation is defined as once pre-operation test period and commissioning has finished for activities involving industrial processes and facilities.

The specific goals of the Municipal Solid Waste Project are:

1. **Waste Reduction:** Drastically reduce the volume of municipal solid waste sent to landfills by incinerating non-recyclable waste.
2. **Greenhouse Gas Mitigation:** Lower methane emissions from landfills, contributing to the reduction of the city's overall greenhouse gas emissions.
3. **Energy Recovery:** Convert waste into energy through the incineration process, generating electricity to be used for the plant operations.
4. **Sustainable Waste Management:** Promote sustainable waste management practices, including waste segregation at the source and enhancing recycling rates.
5. **Environmental Protection:** Minimize environmental hazards such as soil and water contamination associated with landfill sites.
6. **Economic Benefits:** Create job opportunities in the construction and operation of the incineration facility, stimulating the local economy.
7. **Public Health Improvement:** Improve public health by reducing exposure to harmful pollutants from traditional waste disposal methods.

1.4 CCMP description

The Solid Waste to Energy (WtE) project aims to treat municipal solid waste (MSW) by incineration process and also as a byproduct produce energy, typically electricity and heat which is used internally for the operations of the plant. This project involves the construction and operation of a WtE facility that incinerates MSW to produce steam, which drives a turbine to generate

¹ Federal Democratic Republic of Ethiopia Solid Waste Management Advisor for Addis Ababa City, Project Completion Report: This document will be submitted to VVB during the validation.

electricity. The project is designed to operate for a duration of 50 years, ensuring long-term waste management and energy production.

In the absence of the WtE project, MSW would typically be disposed of in open landfills. This process generates significant greenhouse gas emissions, primarily methane (CH₄), due to the anaerobic decomposition of organic waste. Methane is a potent greenhouse gas with a global warming potential much higher than carbon dioxide (CO₂), which is accounted as project emission from the plant operation. Fly ash, which contains more toxic elements, is treated by using chemicals such as activated carbon, sodium bicarbonate, hydrated lime, and collected using bag filters. The fly ash and the slag generated are being dumped in the nearby landfill site. Additionally, the facility includes advanced air pollution control systems to capture and treat pollutants such as nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter (PM).

Leakage in the context of WtE projects refers to the unintended increase in emissions outside the project boundary. For this project, potential leakage could occur if the demand for waste incineration leads to increased waste generation or if waste is diverted from recycling programs to the WtE facility. To mitigate this, the project includes measures to promote waste reduction, recycling, and proper waste segregation at the source. The construction and operation of the WtE facility create employment opportunities in the local community.

Table 1. GHG reduced for Project implementation

GHG type	Activity that generates or reduces it
CH ₄	The major source of GHG emissions is CH ₄ in the baseline scenario and are avoided through Incineration Process.

1.4.1 Sectoral scope and type of CCMP

According to CERCARBONO's protocol, the scale, project type and sectorial scope of the Programme are the following:

Scale:

CCMP Type 1: those removing or reducing on average 10,000 or more tCO₂e per year.

CCMP Type 2: those removing or reducing on average less than 10,000 t CO₂e per year.

The project activity belongs to the category of Waste handling and disposal sector and is eligible as CCMP Type 1 as it reduces more than 10,000 tCO₂e per year.

Sectoral Scope 13: Waste handling and disposal-Waste management sector²

² According to cercarbono protocol <https://www.cercarbono.com/wp-content/uploads/Cercarbonos-Protocol-V-4.4.pdf>

1.4.2 Location and limits of the CCMP

1.4.2.1 Spatial limits

The project is in the Kolfe Keranio sub-city of Addis Ababa, located on the west rim of Ethiopia's Great Rift Valley. In Addis Ababa City, the waste treatment facility exists approximately seven to eight kilometers away from the city center.

This facility is part of the Addis Ababa City Administration and is managed by Ethiopian Electric Power (EEP). The project area is legally defined within the boundaries of the Koshe landfill site, ensuring no overlap with other waste management projects in the region. The project occupies a defined area extending approximately 1 km northward, 1.5 km southward, 2 km eastward, and 1 km westward from its central operational point. This delineation ensures that the project is well-placed to collect municipal waste effectively while minimizing potential overlaps with other environmental and urban projects in the vicinity.

The location of the Reppie waste to energy plant is $8^{\circ}58'34''\text{N}$, $38^{\circ}42'35''\text{E}$, which is located in Addis Ababa city, Ethiopia.



Figure 1 Location of RWEPP plant



Figure 2 Open landfill site near RWEP

1.4.2.2 Time limits

Project developer has chosen the renewable crediting period with first crediting of 10 Years which starts from 01/01/2020 to 31/12/2029 with an option of two times of renewable for a total lifetime up to 30 years. The expected operational lifetime of the project is 50 years³.

First Crediting Period Start date: 01/01/2020

First Crediting Period End date: 31/12/2029

The accreditation period of the project lasts for a period of 10 years, renewable twice as per Cercarbono's Protocol for Voluntary Carbon Certification (Version 4.4)

1.4.2.3 Total area, facilities, or processes

In Addis Ababa City, the waste treatment facility exists approximately seven to eight kilometers away from the city center. The Construction area is about 53,120 m². The facility is regarded as a final disposal complex with the Koshe landfill site and the Reppie waste-to-energy (WtE) facility on the same premises. The total land area of the facility is 39 hectares, of which seven hectares are dedicated to the incineration facility. According to documents issued by the city, this area has been utilized for waste disposal for over 50 years. In order to promote the harmless process of waste treatment to meet the growing needs of MSW treatment in Addis Ababa City, a MSW incineration power plant project is built at the project site.

³ Reppie Waste-to-Energy Project Final Design – Project General Specification – version 3.2 refers page number 183 : This document will be submitted to VVB during the validation

Table 2. Main technical and economic indexes and work amount⁴

No.	Items	Unit	Area
1.	Area In the Red Line	m ²	63,901
	Construction Area	m ²	53,120
2.	Building (Structure) Area	m ²	16,616.05
	Building Coefficient	%	31.28
3.	Road and Site Pavement Area	m ²	10,000
4.	Total Building Area	m ²	21,110.09
	Floor Area Ratio	-	0.397
5.	Area of Green Belt	m ²	15,936
	Green Belt Ratio	%	30
6.	Fence	m	878
7.	Gate	Nr.	2
8.	Quantity of Fill	m ²	11,913
9.	Quantity of Excavation	m ²	52,569
10.	Main building	m ²	18,784.43



Figure 3 Reppie waste to energy plant (RWEP)

⁴ Reppie Waste-to-Energy Project Final Design – Project General Specification – version 3.2 refers page number 172 : This document will be submitted to VVB during the validation

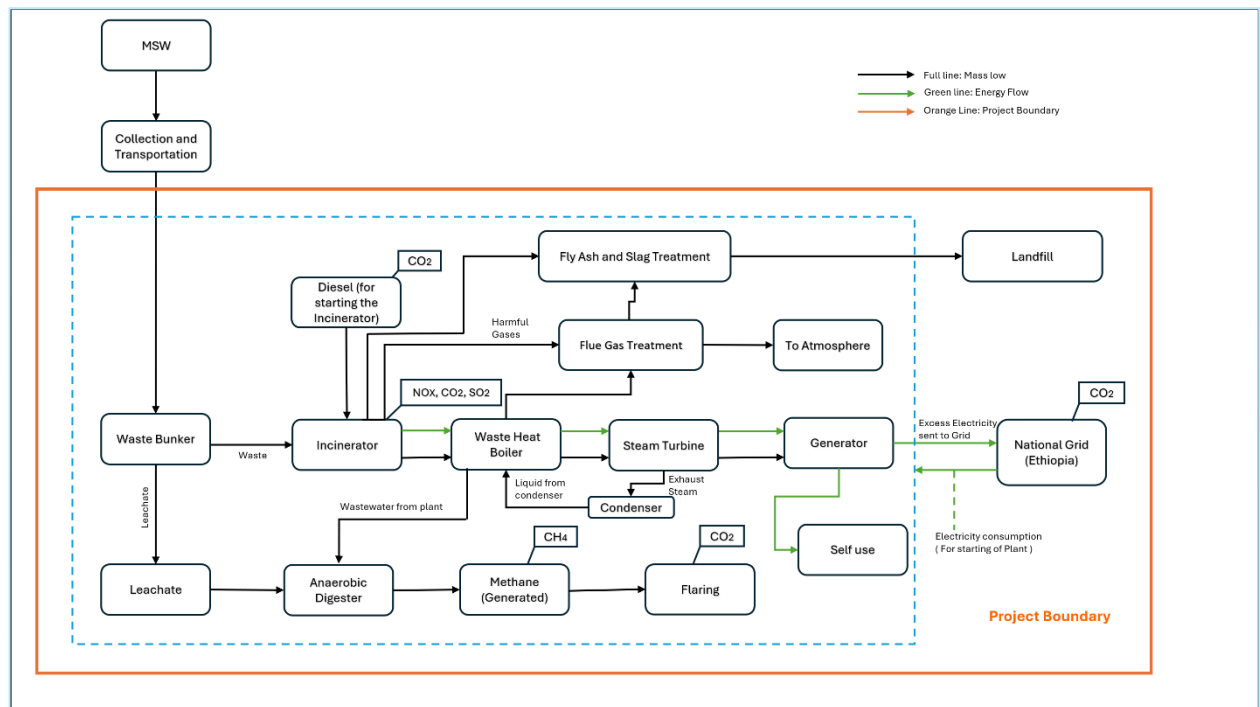


Figure 4. MSW treatment process at RWEPP

1.5 Holdership or right to use the area, facility, or process

The evidence of holdship or property rights over the area(s), facility, or process where the CCMP is or will be implemented is provided to the VVB. The CCMP property is owned by Ethiopian Electric Power Corporation (EEP) and there are no-lien certificates. The relevant Permits for setting up the RWEF has been granted by Ministry of Water and Energy, Ethiopia.

1.6 Characteristics and conditions before the start of the CCMP

The construction of the Reppie WtE facility was completed on 19 August 2018 and generation of emission reductions occurred from 1st January 2020. The facility is owned by EEP, which operates the power generation business. There is a kind of trade-off relationship between EEP and the AACMA, where no direct compensation is exchanged for waste processing. EEP benefits from obtaining waste as a raw material for free, while the AACMA benefits from reducing waste that would otherwise be disposed of in landfills through incineration. This incineration capacity covers approximately 70% of the waste transported to the final disposal site in 2022. As stated above, incineration capacity covered about 70% of waste transported to the final disposal complex in 2022. According to performance records, in 2002 about 1,000 tons of waste were transported daily by sub-city governments, while 734 tons of waste were transported by outsourced/private trucks.

The waste is sent to the plant by the garbage truck, weighed by the weighing scale and unloaded into the Waste bunker. The leachate collection reservoir is constructed at the bottom of the tipping hall to securely contain the collected leachate. The Leachate and wastewater are sent to Anerobic digesters where its breakdown chemically to produce the methane which is flared. After, leachate will enter into the leachate treatment plant for unified treatment and will be discharged into the inland river 200m north of the plant area after it reaches local effluent standard. Waste shall be transferred into the feed hopper by waste grab crane and then pushed into the incinerator for burning. The combustion process converts the chemical energy in the fuel into thermal energy inside the furnace. Some gases like CO₂, NO_x, SO₂, HF, HCL, CO, and dusts are released during incineration. To reduce their environmental impact, the power plant uses chemicals such as activated carbon, sodium bicarbonate, hydrated lime, and bag filters to capture harmful emissions before release. These control measures minimize the release of toxic substances like dioxins and heavy metals. By the process of heat transfer, the boiler then generates superheated steam. The steam is then supplied to the steam turbine where the thermal energy is converted into shaft power. The turbine shaft in turn drives the generator to produce electric power. The exhaust gas will be discharged into the atmosphere after de-acidification, de-dusting and removal of such toxic substances as dioxin in the flue gas treatment (FGT) system. Slag generated and fly ashes collected by the FGT system are transported outside the plant by trucks. Initially, plant source power from the grid, but once power plant begins generating electricity, it utilizes its own generated power. The steam after expanding on the turbine is sent to condenser unit, where it is converted into liquid and sent back to boiler. In addition, the power generated for the plant is used for the plant and the excess power is sent to the National grid. After combustion, the ash and slag will be transferred to the slag removal system by the slag remover via slag chute. The slag from grate will be transferred to the slag remover by the slag conveyor. The boiler ash from the second and third gas flues and that from superheater section will be transferred to the slag remover by respective conveyors, which will be finally transferred to the slag removal system by the slag remover. The boiler ash from the economizer section will be transferred to the fly ash collection system by the conveyor. Flame monitors should be provided for the waste incinerator to ensure that the operator can observe the combustion conditions in the furnace from time to time in the central control room. Bottom ash (slag) and fly ash are transported and damped at the landfill. However, the feasibility study indicated that fly ash can be used for the production of construction materials, such as blocks, etc. At the final disposal complex, 394 tons per day of waste are incinerated at the Reppie WtE facility located adjacent to the landfill site, while the remaining 1,698 tons per day that are not incinerated are disposed of at the landfill site. From the incinerated waste, approximately 85 tons per day of incineration ash are generated, which is either buried at the landfill site or partially utilized as road materials. The amount recycled in the city is estimated to be 228 tons. The city's waste generation amount is 2,647 tons per day. Out of this amount, 85% is collected and transported to the final disposal complex⁵.

⁵ Solid Waste Management Advisor for Addis Ababa City, Project Completion Report: This document will be submitted to VVB during the validation

1.7 CCMP technologies, products, and services

The project design of the project includes two sets of incinerators with hydraulic driven grates with a daily capacity of 1,280 tonnes of waste respectively, each one having a capacity of 640 tonnes per day. The project also involves two sets of 25MW condensing steam turbine generators by using MSW combustion to recover heat to generate power and related auxiliary facilities. The daily processing capacity of the project is 1,280 tons, and the annual processing capacity is 420,000 tons per year on the basis of a 308-day operation(7400 hrs. operation) and produces 185 GWh annually.

Table 3. Specific Information on the Reppie WtE Facility⁶

1.General Profile	
Owner	Ethiopian Electric Power (EEP) Waste Disposal Partner Municipality: Addis Ababa City Administration (AACA)
Total investment	USD 95,880,000 + ETB 434,530,557
Construction area	53,120 m ²
2.Technical Data	
Number of lines	2
Thermal energy capacity per line	36.3 to 55.0 MWth (Megawatts thermal)
Electrical capacity	185 GWh / year
Waste disposal capacity	1,280 tons per day
Capacity for 308 days (7400 hrs. operation)	420,000 tons per annum
Number of truck scales	2 (maximum weighing value of 50 t with accuracy of 20 kg)
Waste pit or bunker capacity	22,000 m ³
Number of tipping platforms	6 waste tipping platform gates
Trucks allowed	>4 t trucks (16 t compactor IVECO trucks replacing fleet)
Tipping hall dimensions	75.6 m x 24 m x 7 m
Combustion systems	
Type	Air-cooled step grate
Grate design	SITY2000 – MARTIN GmbH Licensed
Grate manufacturer	Sanfang - Covanta
Max grate capacity per line	678 tons per day
Grate size per line	9.7 m x 10.6 m

The tables below show the key technical indicators of major equipment

1. Incinerator for MSW⁶

Incinerator	
No.of Incinerators Installed	2
Treatment capacity	640 tonnes/day
Designed MSW heat value	7,000kJ/kg
Range of MSW heat value	7,000 to 9,500kJ/kg
Annual operation time	7,400 hours
Manufactured by	Sanfeng Covanta Environ- ment Industry Co., Ltd

2.Waste Heat Boiler for MSW

Waste Heat Boiler	
No.of Waste Heat Boiler Installed	2
Rated steam outlet pressure	6.0Mpa(g)
Rated steam outlet temperature	420°C
Working pressure of boiler drum	6.7MPa(g)
Working temperature of boiler drum	283°C
Ignition loss	≤3%
Feed water temperature	120°C
Annual operation time	hours
Flue gas flow rate at boiler outlet	129,500 Nm ³ /h
Exhaust gas temperature	195°C
Manufactured by	Hangzhou Boiler Group..
Thermal Efficiency	80.94%

2. Condensing steam turbine for MSW

Condensing steam turbine	
No.of Condensing steam turbine Installed	2
Type	N25-5.8
Turbine Numbers	WT9566 and WT9567
Rated power	25MW
Range of speed	RPM
Rated Inlet steam pressure	5.8 Mpa
Rated Inlet steam temperature	415°C
Rated exhaust pressure	0.0075 Mpa

⁶ Reppie Waste-to-Energy Project Final Design – Project General Specification – version 3.2 refers 32 page: This document will be submitted to VVB during the validation

Condensing steam turbine	
Rated rotation speed	3,000 RPM
Trip speed	3,300(Mechanical)to (Electronic)3,240 RPM
Manufactured by	Hangzhou Steam Turbine Co., Ltd.
Date of manufactured	2015

3. Generator unit for MSW

Generator	
No.of Generators Installed	2
Model	FHWS25-2
Rated Power	25MW
Outgoing Voltage	10,500V
Rotational speed	3,000rpm
Power factor	0.8 (lagging)
The Lifetime of the Generator	30 years
Number of phases	3
Outgoing frequency	50Hz

3. Other units for MSW

Weight Bridge	
No.of units	2
Capacity	50tonnes
Weighing precision	20KG
Dimensions	12m x 3m
Leachate transfer pump	
No.of units	2
Type	Self-suction centrifugal pump
Capacity	50t
Flow	20m ³ /h
Height	30m
Waste Grab crane	
No.of units	2
Volume	8m ³
Capacity	12.5 tonnes
Fully Occupied Grabbing Rate	90 %
Lifting Height	27.6 Meters

Weight Bridge	
Working(Operating) Duration	24
LK	250m
Tipping gate	
No.of units	6
Height	61m
Breadth	3.7m
Waste Bunker	
Capacity	22,658m ³ .
Length	65 meters
Width	≈20.49 meters
Bunker Depth	-3.5 meters
Height of Feeding Hopper	23.1 meters
Waste feeding system	
Dimensions (LxWxH)	6.2m×12.4m×3.1m
capacity	120m ³



Figure 5. Waste Bunker at RWEF

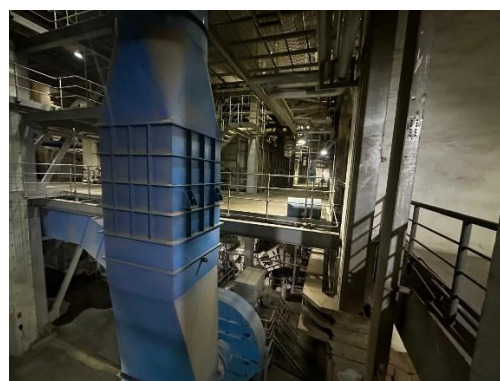
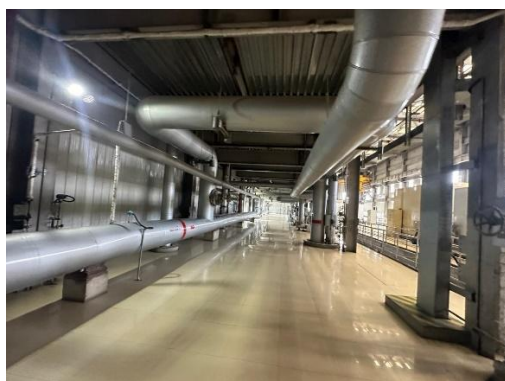


Figure 6. RWEF plant processes

1.8 Chronological plan

The CCMP started its operations on 01/01/2020. While the expected lifetime of project equipment is about 50 years, the expected ending date for the CCMP is in 2070.

The accreditation period of the project lasts for a period of 10 years, renewable twice as per Cercarbono's Protocol for Voluntary Carbon Certification (Version 4.4)

The crediting period is between 01/01/2020 to 31/12/2029

both days inclusive, and renewable twice.

The project will have a monthly monitoring frequency.

Monitoring reports may be requested at least monthly or at most biannually. Frequency of monitoring and verification: periodic verifications for the CCMP are expected to be performed annually. The current monitoring period is from 1st January 2020 to 31st December 2024, a total of 5 years. The subsequent verification PP wishes to conduct once in 2 years.

Events	Dates
Stakeholder Meeting date	10 th January 2014
Plant start up	1 st May 2019
Project registered under the CERCARBONO	16 th January 2025
Validation	On-going
First Verification period	1 st January 2020 to 31 st December 2024
Planned future verifications	1 st January 2025 onwards

2 Methodology

The following UNFCCC methodology and its related tools are utilized: ACM0022: Alternative waste treatment processes - Version 3.0, “Alternative waste treatment processes” is used to establish the baseline under the following conditions.

Table 4. Methodologies and tools

Name of methodology or tool	Justification of applicability for the CCMP (full or partial)	Version
ACM0022:Alternative waste treatment processes.	See section 2.1	3.0
TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (Version 03.0)	Applicable. The emissions from fossil fuel combustion were calculated in the project emission section of the document, which meets the applicability conditions of the tool.	3.0
TOOL 04: Emissions from solid waste disposal sites	Applicable. The project is in line with application B, that avoids the disposal of waste at a SWDS	8.1
TOOL06: Project emissions from flaring	For this project, methane is the component with the highest concentration in the flammable residual gas, all the residual gas is open flared, without the use of auxiliary fuels. This tool is used only for, In the case of open flares, the flare efficiency in the minute m ($\eta_{\text{flare},m}$) is 50%(default value).	4.0
TOOL14:Project and leakage emissions from anaerobic digesters	Applicable. This tool is applicable because the project uses the anerobic digester to produce the methane which is flared.	3.0
TOOL23: Additionality of first-of-its-kind project activities	This tool is applicable because this project will fall under the first-of-its-kind, and it satisfies the applicability conditions of the tool.	3.0

2.1 Applicability of the selected methodology to the CCMP

The following UNFCCC methodology and its related tools are utilized: ACM0022:Alternative waste treatment processes-Version 3.0

Table 5. Applicability of Methodology

Applicable conditions of the Methodology ACM0022	Applicability of this Project
The methodology applies to project activities that install and operate new plants for the treatment of fresh waste through any combination of the following processes: (g) Incineration of fresh waste for the generation of thermal/electric energy.	The project activity is a MSW incineration power plant located at approximately seven to eight kilometers away from the Addis Ababa city center. The waste is converted into electricity by incineration process, all the energy produced is used by itself and excess will be sent to National Grid, so that the project is applicable to the conditions.
The following conditions apply to all project activities using this methodology: (i) The project plant only treats fresh waste/wastewater for which emission reductions are claimed, except for cases involving composting, co-composting and anaerobic digestion;	The project only treats fresh MSW, and the waste treatment method is incineration, from which the emission reduction is only claimed.
(j) Neither the fresh waste nor the products from the project plant are stored on-site under anaerobic conditions;	The project meets the requirement. As the project is of incineration of MSW, the waste and the products are stored under anaerobic conditions. Fresh waste is collected daily and placed in a Waste bunker for 4 to 5 days, then being put into the incinerator after leachate leaks out. The waste bunker is equipped with ventilation equipment and the process includes regular stirring of the waste using a Grab crane, thus ensuring that none of the waste is left in an anaerobic environment. In addition, the combustion air for the incinerator is extracted from the waste bunker, confirming that the waste in the waste bunker is in an aerobic environment. The products of the project are electricity, which does not involve anaerobic storage, and the by-products are immediately and properly disposed of without anaerobic storage.

(k) Any wastewater discharge resulting from the project activity is treated in accordance with applicable regulations;	The project meets the requirement. All of the production wastewater generated during the project activities is treated in the plant and then reused. Since all wastewater is reused and no discharge is involved, compliance with the relevant pollution discharge regulations is not involved.
(l) The project activity does not reduce the amount of waste that would be recycled in the absence of the project activity.	The project meets the requirement since there is no recycled waste under the baseline scenario. Prior to the project, all the waste is treated at a koshe landfill, there is no recycled waste.
(m) When applicable regulations mandate any waste treatment process implemented under the project activity, the rate of compliance with such regulations for the treatment process is below 50 per cent;	There is no mandatory or legal requirement to implement the incineration process, so there is no rate of compliance.
(n) Hazardous wastes/wastewater are not eligible under this methodology.	As the project is of incineration of MSW, there is no hazardous wastes and wastewater involved.
The methodology is only applicable if the baseline scenario is: (a) The disposal of the fresh waste in a SWDS with or without a partial LFG capture system (M2 or M3) (c) M3: Disposal of the fresh waste in a SWDS without a LFG capture system	Prior to the project, all the waste is dumped at a koshe landfill, without a partial LFG capture system (M3). Supplementary explanation for the waste disposal baseline scenario of this project: Before the implementation of the project activities, the waste disposed of in landfill site. According to the FSR of the project, without the construction of this project, the area would continue to be used as a landfill.
Specific applicability conditions for the different waste treatment processes: Waste treatment option under the project activity: Incineration. Applicable types of wastes that may be treated: Fresh waste. Applicable products and their use: Electricity and/or heat.	The project complies with the provisions of the methodology. As an incineration project, the project treats fresh MSW, provides electricity as product. The annual power generation of the project is 185 GWh annually. The main by-products produced by the project activities are incineration products

Applicable waste by-products: Incineration by-product (e.g. inert materials); Wastewater discharge; non-biodegradable materials that may have market value (i.e. glass, metals and plastics). The fraction of energy generated by auxiliary fossil fuels is not more than 50% of the total energy generated in the incinerator.	(including flue gases, dusty waste gases, malodorous gases, slag and fly ash). Specific applicability conditions for the different processes are provided in the Table below.
In addition, the applicability conditions included in the tools referred to below apply.	
TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion (Version 03.0) This tool provides procedures to calculate project and/or leakage CO₂ emissions from the combustion of fossil fuels. It can be used in cases where CO₂ emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and its properties. Methodologies using this tool should specify to which combustion process j this tool is being applied.	Applicable. The emissions from fossil fuel combustion were calculated in the project emission section of the document, which meets the applicability conditions of the tool.
TOOL 04: Emissions from solid waste disposal sites	
3. The tool can be used to determine emissions for the following types of applications: (a) Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. “ACM0001: Flaring or use of landfill gas”). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex ante estimation of emissions in the project design document (CDM-PDD). The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS);	Applicable. The project is in line with Application B, which avoids the disposal of waste at a SWDS. As per Point 3(b), the tool can be applied for both ex ante and ex post estimation of emissions. Additionally, point 5 is applicable as the project involves different types of residual waste being prevented from disposal, so the tool should be applied separately to each type of waste and municipal solid waste (MSW).

(b) Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.

4. These two types of applications are referred to in the tool for determining parameters.

5. In the case that: (a) different types of residual waste are disposed or prevented from disposal; or that (b) both MSW and residual waste(s) are prevented from disposal, then the tool should be applied separately to each residual waste and to the MSW.

TOOL06: Project emissions from flaring.

2. This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.

3. This tool is applicable to the flaring of flammable greenhouse gases where:

(a) Methane is the component with the highest concentration in the flammable residual gas; and

For this project 3(a) is applicable. Methane is the component with the highest concentration in the flammable residual gas, all the residual gas is open flared, without the use of auxiliary fuels. This tool is used only for, In the case of open flares, the flare efficiency in the minute m ($\eta_{\text{flare},m}$) is 50%(default value). The 4th point is not applicable to this project

(b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas). 4. The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. In the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare and these shall be followed by the project participant.	
TOOL14: Project and leakage emissions from anaerobic digesters	
3. The following sources of project emissions are accounted for in this tool: (a) CO₂ emissions from consumption of electricity associated with the operation of the anaerobic digester; (b) CO₂ emissions from consumption of fossil fuels associated with the operation of the anaerobic digester; (c) CH₄ emissions from the digester (emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester); and (d) CH₄ emissions from flaring of biogas. 4. The following sources of leakage emissions are accounted for in this tool: (a) CH₄ and N₂O emission from composting of digestate; (b) CH₄ emissions from the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage, such as in a stabilization pond.	This tool is applicable. By storing the wastewater and leachate in the anaerobic digester, it will decompose in the digester and produce the methane, and it is flared. 3(d), 4(b) is applicable and the N₂O emissions from physical leakages from the digester is not applicable to this project.

5. N₂O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid digestate and land application of the digestate are not included because these are minor emission sources or because they are accounted in the methodologies referring to this tool.	
TOOL23: Additionality of first-of-its-kind project activities	This tool is applicable because this project will fall under the first-of-its-kind, and it satisfies the applicability conditions of the tool. The project qualifies as "First of Its Kind" due to several factors: 1. Technological Innovation: The incineration technology used for Waste-to-Energy (WtE) is novel in Ethiopia, with no other similar plants operational in 2019. 2. GHG Emission Reduction: By using municipal solid waste (MSW) as fuel, the project prevents methane emissions from open dumping, a common practice in Ethiopia. It also generates thermal energy and electricity, which is unique to the region. 3. Barriers to Adoption: The project faces significant challenges due to high upfront costs, financing difficulties, and low investor confidence in new WtE technologies in Ethiopia. These factors demonstrate the project's "first-of-its-kind" nature, qualifying it for additionality under carbon crediting frameworks.

Table 6 Specific applicability conditions for the different waste treatment processes

Waste treatment option under the project activity	Applicable types of wastes that may be treated	Applicable products and their use	Applicable waste by-products	Specific applicability conditions for the treatment option
Composting or co-composting	- Types of waste specified in the scope and applicability section of the methodological tool “Project and leakage emissions from composting”. - Run-off wastewater - Excluding hospital and industrial waste	Compost: any use applicable	- Glass, aluminum, ferrous metals and plastics from waste sorting stages. - Run-off wastewater	Any applicability conditions specified in the methodological tool “Project and leakage emissions from composting”
Justification: The proposed project is an incineration process and does not involve any composting process; so, the criterion is not applicable for the proposed project activity.				
Anaerobic digestion	- Wastewater. - Fresh Waste, - Wastewater discharge	Biogas which may be flared, used to generate electricity or heat, and/or is upgraded and distributed in a natural gas distribution grid	Non-biodegradable materials that may have market value (i.e. glass, metals and plastics); Wastewater discharge Digestate.	Any applicability conditions specified in the methodological tool “Project and leakage emissions from anaerobic digesters”
Justification: The proposed project is an incineration process and does not involve any anaerobic digestion of wastewater or fresh waste; so, the criterion is not applicable for the proposed project activity.				
Waste treatment option under the project activity	Applicable types of wastes that may be treated	Applicable products and their use	Applicable waste by-products	Specific applicability conditions for the treatment option

Thermal treatment	Fresh waste, excluding hospital and industrial waste	RDF/SB; any use is applicable	Glass, aluminum and ferrous metals from waste sorting stages	-
Justification: The proposed project is an incineration process and does not involve thermal process; so, the criterion is not applicable for the proposed project activity.				
Mechanical treatment	Fresh waste, excluding hospital and industrial waste	RDF/SB; any	- Run-off wastewater; - Glass, aluminum and ferrous metals from waste sorting stages	-
Justification: The proposed project is an incineration process and does not involve Mechanical treatment process; so the criterion is not applicable for the proposed project activity.				
Gasification	Fresh waste	Syngas which may be used to generate electricity and/or heat	- Gasification byproducts (e.g. inert materials); - Run-off wastewater; - Glass, aluminum and ferrous metals from waste sorting stages	
Justification: The proposed project is an incineration process and does not involve any gasification process; so the criterion is not applicable for the proposed project activity.				
Waste treatment option under the project activity	Applicable types of wastes that may be treated	Applicable products and their use	Applicable waste by-products	Specific applicability conditions for the treatment option
Incineration	Fresh waste	Electricity and/or heat	Incineration byproduct (e.g. Inert materials);	Incineration technology is rotary kiln, rotating fluidized bed,

			• Run-off wastewater; • Glass, aluminum and ferrous metals from waste sorting stages	• circulating fluidized bed, hearth or grate type; • The fraction of energy generated by auxiliary fossil fuels is not more than 50% of the total energy generated in the incinerator
Justification: The proposed project is an incineration process, and the waste is converted into electricity by the incineration process, all the energy produced is used by itself and excess will be sent to National Grid, so that the project is applicable to the conditions. So, it is applicable.				

Related Tools:

The methodology also refers to the latest approved version of the following CDM tools:

TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion-3.0

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf>

TOOL 04: Emissions from solid waste disposal sites-8.1

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.1.pdf>

TOOL06: Project emissions from flaring-4.0

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v4.0.pdf>

2.2 Additionality

The additionality of the project is established by use of the first of its kind approach. CDM tool No. 23, Additionality of first-of-its-kind project activities, V 3.0 is used to justify the additionality of the project activity.

This project uses Municipal Solid waste as fuel and thus avoids emission of methane from open dumping of municipal solid waste, which is the usual practice in Ethiopia. Additionally, the project generates thermal energy from which electricity is generated. In our opinion, the project qualifies under the First of Its Kind approach due to the following reasons.

1. Technological Innovation: The technology (Incineration) used in the RWEF project is novel in Ethiopia and carries significant operational and technological risks. There are no other WtE (waste to energy) plants using similar technology and fuel which are operational in 2019 in Ethiopia when the plant was commissioned. The list of other types of thermal energy plants operational as of May 2019, with technology and input fuel is provided to VVB.
2. Measures to reduce GHG emissions and provide output: The RWEF plant uses Municipal Solid waste as fuel and thus avoids emission of methane from open dumping of municipal solid waste, which is the usual practice in Ethiopia. Additionally, the project generates thermal energy from which electricity is generated. These measures and output are unique in Ethiopia. The list of other types of thermal energy plants operational as of May 2019, with measures and output is provided as an annex to this document.

Due to the novel technology and considering the status of Ethiopia as a LDC, the high upfront costs, financing challenges, and lack of investor confidence in new waste-to-energy technologies in Ethiopia were challenges which existed for adoption of such a technology.

Hence, from the above analysis, a **waste-to-energy project in Ethiopia** can effectively demonstrate that it faces significant **"first-of-its-kind" barriers** and therefore qualifies for **additionality** under the **carbon crediting framework**.

Further, the project has also demonstrated additionality based on the "Tool to Demonstrate Additionality of Climate Change Mitigation Initiatives" v2.0.1. According to section 5.1, which details the steps for first of its kind approach.

i) CCMP should clearly define what the prevailing practice(s) are, what the CCMP technology is and what is considered a similar technology - Open dumping of municipal solid waste, which is the usual practice in Ethiopia is considered as the baseline and the prevailing practice. There are no other WtE (waste to energy) plants using similar technology and fuel which are operational in 2019 in Ethiopia when the plant was commissioned. The list of other types of thermal energy plants operational as of May 2019, with technology and input fuel is provided to VVB.

ii) CCMP should clearly define the applicable geographical area in the first-of-a-kind context. – Considering the novel technology and considering the status of Ethiopia as a LDC, the high upfront costs, financing challenges, and lack of investor confidence in new waste-to-energy technologies in Ethiopia were challenges which existed for adoption of such a technology in 2019. Hence in this context, country of Ethiopia is defined as the applicable geographical area for application of the first-of-a-kind approach.

iii) In the case of CCMP that started implementation prior to validation, the analysis will be done for the situation at the time implementation started, including also other possible CCMP in validation, or already implemented at the time of the analysis - The RWEF plant uses Municipal Solid waste as fuel and thus avoids emission of methane from open dumping of municipal solid waste, which is the usual practice in Ethiopia. Additionally, the

project generates thermal energy from which electricity is generated. These measures and output are unique in Ethiopia. The list of other types of thermal energy plants operational as of May 2019, with measures and output is provided as an annex to this document.

2.3 No double counting

The CCMP holder states that the project has not been previously registered in any program, so double counting of credits and environmental attributes is being avoided. Further the CCMP holder informs that the project has not been registered under any other carbon crediting or off-setting programme, it will not seek doing so, and emission reductions achieved will only be counted and used once for credit trading and accounting purposes under CERCARBONO program only. A declaration to this effect will be submitted to VVB.

2.4 Baseline scenario

The baseline scenario typically involves disposing of MSW in open landfills, leading to significant methane emissions. The Climate Change Mitigation Project (CCMP) focuses on converting municipal solid waste (MSW) into energy. There are no barriers or conditions preventing it from continuing during the CCMP's implementation. The project has complied with all the regulatory policies and requirements of the host country. The primary greenhouse gas (GHG) emission sources in this context include methane emissions from landfills, carbon dioxide (CO₂) emissions from waste combustion, and emissions from the transportation of waste to disposal sites. In the absence of project, the baseline scenario would be the dumping of MSW in koshe landfill site which leads to significant methane emissions.

2.5 Project scenario

The Waste-to-Energy (WtE) project involves converting municipal solid waste into energy through incineration, significantly reducing GHG emissions by displacing more GHG-intensive landfill operations. The main technologies include modern incinerators equipped with advanced emissions control systems, typically with a lifespan of 50 years. These systems have high efficiency rates, converting waste into electricity and heat. The project modifies existing waste management systems by integrating incineration facilities, which handle large volumes of waste and produce substantial energy outputs. In the baseline scenario, waste would be landfilled, generating methane, a potent GHG. The project quantifies GHG reductions by comparing emissions from incineration to those from landfilling, using standardized measurement protocols to ensure accuracy and reliability. Existing facilities include landfills and recycling centers, which are less efficient in terms of energy recovery and GHG emissions reduction.

2.6 GHG emission sources

Table 7. GHG Activities

Activity	Baseline scenario			Project scenario			Leakage		
	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O
Emissions at the SWDS	NO	YES	NO	NO	NO	NO	NO	NO	NO
Emissions from on-site fossil fuel consumption due to the project activity other than for electricity generation	NO	NO	NO	YES	NO	NO	NO	NO	NO
Emissions from the waste treatment processes	NO	NO	NO	YES	YES	YES	NO	NO	NO
Emissions from wastewater treatment.	NO	NO	NO	NO	YES	NO	NO	NO	NO

2.7 Methodological deviations

There are no methodological deviations contemplated for this project.

2.8 Accreditation period

The first crediting period of the CCMP starts from 01/01/2020 to 31/12/2029 and will be renewed twice.

3 Quantification of GHG emissions and GHG emission reductions

3.1 Quantification of GHG emissions in the baseline scenario

As per the applied methodology ACM0022, version 3.0, baseline emissions may comprise of the following sources:

- A. Methane emissions from the SWDS in the absence of the project activity;
- B. Methane emissions from the treatment of organic wastewater in the absence of the project activity;
- C. Energy generated or electricity consumed by the grid in the absence of the project activity;
- D. Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = \sum (BE_{CH_4,t,y} + BE_{WW,t,y} + BE_{EN,t,y} + BE_{NG,t,y}) \times (1 - RATE_{compliance,t})$$

Where:

BE_y = Baseline emissions in year y (t CO₂e)

$BE_{CH_4,t,y}$ = Baseline emissions of methane from the SWDS in year y (t CO₂e)

$BE_{WW,t,y}$ = Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (t CO₂e)

$BE_{EN,t,y}$ = Baseline emissions associated with energy generation in year y (t CO₂)

$BE_{NG,t,y}$ = Baseline emissions associated with natural gas use in year y (t CO₂)

$RATE_{compliance,t}$ = Discount factor to account for the rate of compliance of a regulatory requirement that mandates the use of alternative waste treatment process t

t = Type of alternative waste treatment process

For the proposed project activity, the baseline emissions will comprise of (a) Methane emissions from the SWDS in the absence of the project activity.

The other two sources stated above (B,C and D) are not applicable.

1. Baseline emissions of methane from the SWDS ($BE_{CH_4,t,y}$)

As per the methodology ACM0022 version 3.0, “baseline emissions of methane from the SWDS are determined using the methodological tool “Emissions from solid waste disposal sites”. The following requirements shall be complied with when applying the tool:”

1) $W_{j,x}$ in the tool is the amount of organic fresh waste prevented from disposal in the baseline SWDS due to its treatment in any (combination) alternative waste treatment option;

- $W_{j,x}$ as mentioned in the said tool is the amount of organic fresh waste prevented from disposal in the baseline SWDS due to its treatment by the project activity.

2) Emissions are calculated using Application B in the tool, meaning that only waste avoided from the disposal after the start of the first crediting period shall be considered in the tool;

- Emissions shall be calculated using Application B in the said tool.

3) Sampling to determine the fractions of different waste types is necessary (note that for the case that the waste is combusted in the project activity, then the parameter $Q_{j,c,y}$ in this methodology is equivalent to the variable $W_{j,x}$ in the tool);

- A sampling procedure shall be followed according to the methodology, ACM0022 version 3.0, to determine the fraction of different waste types in the project activity

4) The tool instructs that f_y shall be determined based on historic data or contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available). The following additional instruction applies:

(a) If the regulation requirements specify a percentage of the LFG that is required to be flared, the amount shall equal f_y ;

(b) If the regulation requirements do not specify the amount or percentage of LFG that should be destroyed but require the installation of a capture system, without requiring the captured LFG to be flared then $f_y = 0$; and

(c) If the requirement do not specify any amount or percentage of LFG that should be destroyed but requires the installation of a system to capture and flare the LFG, then it is assumed $f_y = 0.2$

As per the methodology, baseline emissions have been computed as per the Tool “Emissions from solid waste disposal sites (Version 8.1)” the procedures to calculate baseline, project or leakage emissions of methane from solid waste disposed or prevented from disposal at a Solid Waste Disposal Site (SWDS) with the consideration of the above-mentioned requirements.

For the Calculation of baseline emissions from the project activity Application B is chosen due to the following reason: The project activity involves treating the MSW waste through incineration and preventing it from being disposed in solid waste disposal sites; and the methane that would have been generated is avoided from SWDS during the crediting period

and will not mitigate methane emissions from a specific existing SWDS by capturing and flaring or combusting methane.

- The amount of methane generated from disposal of waste at the SWDS is calculated based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respective constant decay rates (k_j) and fractions of degradable organic carbon (DOC_j).
- The model calculates the methane generation occurring in year y (a period of 12 consecutive months) or month m based on the waste streams of waste types j ($W_{j,x}$ or $W_{j,i}$) disposed in the SWDS over a specified time period (years).
- In cases where at the SWDS methane is captured (e.g. due to safety regulations) and flared, combusted or used in another manner that prevents emissions of methane to the atmosphere, the emissions are adjusted for the fraction of methane captured (f_y).

It is worthwhile to note that in the project activity baseline the SWDS methane is not captured therefore $f_y = 0$.

The amount of methane generated from disposal of waste at the SWDS is calculated for year y ($BE_{CH_4,SWDS,y}$) using the following equation:

$$BE_{CH_4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y (W_{j,x} \times DOC_j \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j}))$$

Where:

$BE_{CH_4,SWDS,y}$ = Baseline, project or leakage methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO₂e/yr)

x = Years in the time period in which waste is disposed of at the SWDS, extending from the first year in the time period ($x = 1$) to year y ($x = y$)

y = Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)

$W_{j,x}$ = Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)

ϕ_y	= Model correction factor to account for model uncertainties for year y
f_y	= Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH_4}	= Global Warming Potential of methane
F	= Fraction of methane in the SWDS gas (volume fraction)
MCF_y	= Methane correction factor for year y
DOC_j	= Fraction of degradable organic carbon in the waste type j (weight fraction)
k	= Decay rate for the waste type j (1 / yr)
j	= Type of residual waste or types of waste in the MSW

1.1.Determining the model correction factor (ϕ_y)

If baseline emissions are being calculated, the project participants may choose between the following two options to calculate ϕ_y :

Option 1: Use a default value

The parameter ϕ_y is used for baseline calculation, and Option 1: Use a default value is chosen. $\phi_y = \phi_{\text{default}}$

1.1.2.Determining the amounts of waste type j disposed in the SWDS ($W_{j,x}$)

Where different waste types j is disposed of or prevented from disposal in the SWDS, it is necessary to determine the amount of different waste types ($W_{j,x}$). In this case, Application B is determined.

$$W_{j,x} = W_x \times p_{j,x}$$

Where:

$W_{j,x}$	= Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)
W_x	= Total amount of solid waste disposed or prevented from disposal in the SWDS in year x (t)
x	= Years in the time period for which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)
$p_{j,x}$	= Average fraction of the waste type j in the waste in year x (weight fraction)
j	= Types of solid waste

The fraction of the waste type j in the waste for the year x are calculated according to the following formula:

$$p_{j,x} = \frac{\sum_{n=1}^{Z_x} (pn,j,x)}{Z_x}$$

Where:

$p_{j,x}$ = Average fraction of the waste type j in the waste in year x (weight fraction)

pn,j,x = Fraction of the waste type j in the sample n collected during the year x (weight fraction)

Z_x = Number of samples collected during the year x

n = Samples collected in year x

j = Types of solid waste

x = Years in the time period for which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)

1.1.3.Determining the parameters required to apply the FOD model

This includes the use of default values or project specific value estimated yearly. The time period in which waste disposal is considered in the calculation is the first credit period (7 years)

1.1.4.Determining the fraction of DOC that decomposes in the SWDS ($DOC_{f,y}$)

For Application B, the PP may choose to either apply a default value or determine $DOC_{f,y}$ based on measurements of the biochemical methane potential of the MSW. The PP has chosen the default value of $DOC_{f,y}$.

The default value ($DOC_{f,y} = DOC_{f,default}$) is chosen.

1.1.5.Determine the methane correction factor (MCF y)

The SWDS is not the condition that a water table above the bottom (such as, using waste to fill inland water bodies, such as ponds, rivers or wetlands), thus a default value ($MCF_y = MCF_{default}$) is used.

2. Baseline emissions from organic wastewater ($BE_{ww,t,y}$)

There is no treatment of wastewater in the proposed project activity; therefore, Procedure (B) does not apply for baseline calculation. $BE_{ww,t,y}=0$

3. Baseline emissions from generation of energy ($BE_{EN,y}$)

As the heat generation is not a baseline scenario, the procedure is not applied. Therefore, it is not applicable. $BE_{EN,y}=0$

3.1.3 Cogeneration of electricity and heat.

There is no electricity and heat cogeneration are involved or calculated in the project, so it is not applicable.

4. Baseline emissions associated with natural gas use ($BE_{NG,y}$)

The baseline scenario is not involved with natural gas use; therefore, it is not applicable. $BE_{NG,y}=0$

3.2 Quantification of GHG emissions and reductions of GHG emissions in the project scenario

The project emissions in year y are calculated for each alternative waste treatment process implemented in the project activity as follows:

$$PE_y = PE_{COMP,y} + PE_{AD,y} + PE_{GAS,y} + PE_{RDF_SB,y} + PE_{INC,y}$$

Where:

PE_y = Project emissions in year y (t CO₂e)

$PE_{COMP,y}$ = Project emissions from composting or co-composting in year y (t CO₂e)

$PE_{AD,y}$ = Project emissions from anaerobic digestion and biogas combustion in year y (t CO₂e)

$PE_{GAS,y}$ = Project emissions from gasification in year y (t CO₂e)

$PE_{RDF_SB,y}$ = Project emissions associated with RDF/SB in year y (t CO₂e)

$PE_{INC,y}$ = Project emissions from incineration in year y (t CO₂e)

The proposed project does not involve with the composting, gasification, anaerobic digestion and RDF/SB processing.

1. Project emissions from composting or co-composting ($PE_{COMP,y}$)

The project activity of this project does not involve composting, so that $PE_{COMP,y} = 0$.

2.1. Project emissions from anaerobic digestion ($PE_{AD,y}$)

The project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y}$$

Where:

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year y (t CO₂e)

$PE_{EC,y}$ = Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO₂e)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with the anaerobic digester in year y (t CO₂e)

$PE_{CH_4,y}$ = Project emissions of methane from the anaerobic digester in year y (t CO₂e)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (t CO₂e)

2.1.2. Determination of project emissions from electricity consumption ($PE_{EC,y}$)

This step is applicable if the anaerobic digester consumes electricity, such as for mixing, recirculation of digestate, or processing of feed material. The grid emission factor Ethiopia is zero. If the electricity consumed is generated on-site using biomass residues, wind, hydro or geothermal power, then $PE_{EC,y} = 0$. Otherwise, the project participants may choose between the following two options to calculate $PE_{EC,y}$:

The electricity consumed is generated on-site using biomass residues, wind, hydro or geothermal power, then $PE_{EC,y} = 0$.

2.1.3. Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

The project emissions from fossil fuel consumption for Anaerobic digester is not applicable so $PE_{FC,y} = 0$

2.1.4. Determination of project emissions of methane from the anaerobic digester ($PE_{CH_4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH_4,default}$), as follows:

$$PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4}$$

Where:

$PE_{CH_4,y}$ = Project emissions of methane from the anaerobic digester in year y (t CO₂e)

$Q_{CH_4,y}$ = Quantity of methane produced in the anaerobic digester in year y (t CH₄)

$EF_{CH_4,default}$ = Default emission factor for the fraction of CH₄ produced that leaks from the anaerobic digester (fraction)

GWP_{CH_4} = Global warming potential of CH₄ (t CO₂ / t CH₄)

2.1.5. Determination of the quantity of methane produced in the digester ($Q_{CH_4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH_4,y}$). For this project only Option 2 is to be used.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas, as follows:

$$Q_{CH_4,y} = Q_{biogas,y} \times f_{CH_4,default} \times \rho_{CH_4}$$

Where:

$Q_{CH_4,y}$ = Quantity of methane produced in the digester in year y (t CH₄)

$Q_{biogas,y}$ = Amount of biogas collected at the digester outlet in year y (Nm³ biogas)

$f_{CH_4,default}$ = Default value for the fraction of methane in the biogas (m³ CH₄ / m³ biogas)

ρ_{CH_4} = Density of methane at normal conditions (t CH₄ / Nm³ CH₄)

2.1.5. Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the “Tool to determine project emissions from flaring gases containing methane”. The following applies:

(a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH_4,default}$) in applying the tool; and

(b) The tool provides default factors for the flare efficiency, which can be used for large- or small-scale projects as described in the tool.

Note: For ex ante calculations of project emissions from wastewater discharge management, where monitoring data are not available, considering the need for conservative estimates, the equation in ACM0022 can be used.

$$PE_{flare,t,y} = Q_{ww,y} \times P_{COD,y} \times B_0 \times MCF_{ww} \times GWP_{CH_4}$$

Where:

$PE_{flare,t,y}$ = Project emissions of methane from wastewater discharge associated with alternative waste treatment process t in year y (t CO₂e)

$Q_{ww,y}$ = Amount of wastewater discharge generated by the project activity and treated anaerobically or released untreated from the project activity in year y (m³)

$P_{COD,y}$ = COD of the wastewater discharge generated by the project activity in year y (tCOD/m³)

B_0 = Maximum methane producing capacity, expressing the maximum amount of CH₄ that can be produced from a given quantity of chemical oxygen demand (t CH₄/tCOD)

MCF_{ww} = Methane conversion factor (fraction)

GWP_{CH_4} = Global Warming Potential of methane valid for the commitment period (t CO₂e/t CH₄)

3. Project emissions from gasification ($PE_{GAS,y}$)

The project activity of this project does not involve gasification, so that $PE_{GAS,y} = 0$.

4. Project emissions associated with mechanical or thermal production of RDF/SB ($PE_{RDF_SB,y}$)

The project activity of this project does not involve mechanical or thermal production of RDF/SB, so that $PE_{RDF_SB,y} = 0$.

5. Project emissions from incineration ($PE_{INC,y}$)

Project emissions from incineration include emissions from combustion within the project boundary ($PE_{COM,INC,y}$)

$$PE_{INC,y} = PE_{COM,INC,y} + PE_{EC,INC,y} + PE_{FC,INC,y} + PE_{ww,INC,y}$$

Where:

$PE_{INC,y}$ = Project emissions from incineration in year y (t CO₂e)

$PE_{COM,INC,y}$ = Project emissions from combustion within the project boundary of fossil waste associated with incineration in year y (t CO₂)

$PE_{EC,INC,y}$ = Project emissions from electricity consumption associated with incineration year y (t CO₂e)

$PE_{FC,INC,y}$ = Project emissions from fossil fuel consumption associated with incineration in year y (t CO₂e)

$PE_{ww,INC,y}$ = Project emissions from the wastewater treatment associated with incineration in year y (t CH₄)

$PE_{EC,INC,y}$ is determined according to the procedure "Project emissions from electricity use", where $PE_{EC,INC,y} = PE_{EC,t,y}$ and the alternative waste treatment option t is incineration.

$PE_{COM,INC,y}$ is determined according to the procedure “Project emissions from combustion within the project boundary”, where $PE_{COM,INC,y} = PE_{COM,c,y}$ and the combustor c is the incinerator.

$PE_{FC,INC,y}$ is determined according to the procedure “Project emissions from fossil fuel use”, where $PE_{FC,INC,y} = PE_{FC,t,y}$ and the alternative waste treatment option t is incineration.

$PE_{ww,INC,y}$ is determined according to the procedure “Project emissions from wastewater treatment”, where $PE_{ww,INC,y} = PE_{ww,t,y}$ and the alternative waste treatment option t is incineration.

5.1. Project emissions from combustion within the project boundary ($PE_{COM,c,y}$)

This procedure estimates emissions from gasifiers, incinerators, RDF/SB combustors and syngas burners ($PE_{COM,c,y}$). The procedure is not relevant for flares or biogas combustors. Emissions consist of carbon dioxide, and small amounts of methane and nitrous oxide, as follows:

$$PE_{COM,c,y} = PE_{COM,CO_2,c,y} + PE_{COM,CH_4,N_2O,c,y}$$

Where:

$PE_{COM,c,y}$ = Project emissions from combustion within the project boundary associated with combustor c in year y (t CO₂e)

$PE_{COM,CO_2,c,y}$ = Project emissions of CO₂ from combustion within the project boundary associated with combustor c in year y (t CO₂)

$PE_{COM,CH_4,N_2O,c,y}$ = Project emissions of CH₄ and N₂O from combustion within the project boundary associated with combustor c in year y (t CO₂)

c = Combustor used in the project activity: gasifier or syngas burner, incinerator or RDF/SB combustor

5.1.1. Project emissions of CO₂ from combustion within the project boundary ($PE_{COM,CO_2,c,y}$)

Carbon dioxide project emissions associated with on-site combustion ($PE_{COM,CO_2,c,y}$) are calculated based either on the fossil carbon content of the fresh waste or RDF/SB combusted, or on the fossil carbon content of the stack gas. The biogenic carbon content is not considered.

Project participants may select from three options to calculate $PE_{COM,CO_2,c,y}$. Option 1 requires sorting the fresh waste into components of waste type j and then determining the fossil-based carbon content of each waste type j . Option 2 determines the fossil-based carbon content of the unsorted fresh waste or RDF/SB (noting that Option 1, sorting into waste fractions, is not applicable if only RDF/SB is combusted). Option 3 measures directly the fossil-based carbon content of the stack gas.

For gasifiers producing syngas for on-site utilisation, the fossil carbon content is determined and accounted for once, either evaluating the waste composition at the gasifier's inlet (Options 1, 2), or the stack gas at the syngas' stack (Option 3). All the syngas has to be combusted.

Option 1: Waste sorted into waste type fractions

$$PE_{COM,CO_2,c,y} = EFF_{COM,c,y} \times \frac{44}{12} \times \sum_i Q_{j,c,y} \times FCC_{j,y} \times FFC_{j,y}$$

Where:

$PE_{COM,CO_2,c,y}$ = Project emissions of CO₂ from combustion within the project boundary associated with combustor c in year y (t CO₂)

$Q_{j,c,y}$ = Quantity of fresh waste type j fed into combustor c the in year y (t)

$FCC_{j,y}$ = Fraction of total carbon content in waste type j in year y (t C/t)

$FFC_{j,y}$ = Fraction of fossil carbon in total carbon content of waste type j in year y (weight fraction)

$EFF_{COM,c,y}$ = Combustion efficiency of combustor c in year y (fraction)

$\frac{44}{12}$ = Conversion factor (t CO₂/t C)

c = Combustor used in the project activity: gasifier, incinerator or RDF/SB combustor

j = Waste type

Project participants may select to either directly monitor the amount of waste type j fed into the combustor c in year y ($Q_{j,c,y}$) or calculate this parameter based on monitoring the total waste fed to the combustor and sampling the waste to determine the fraction of waste type j as per the following equation:

$$Q_{j,c,y} = Q_{waste,c,y} \times \frac{\sum_{n=1}^z P_{n,j,y}}{z}$$

Where:

$Q_{j,c,y}$ = Quantity of waste type j fed into combustor c in year y (t)

$Q_{waste,c,y}$ = Quantity of fresh waste or RDF/SB fed into combustor c in year y (t)

$P_{n,j,y}$ = Fraction of waste type j in the sample n collected during the year y (weight fraction)

z = Number of samples collected during the year y

n = Samples collected in year y

j = Waste type

5.1.2. Project emissions of CH₄ and N₂O from combustion within the project boundary ($PE_{COM_CH4,N2O,c,y}$)

Emissions of N₂O and CH₄ from combustion of RDF/SB are neglected because they are considered very minor. For the case of gasification or incineration, project participants may choose either Option 1 or Option 2 to estimate emissions of N₂O and CH₄ from combustion within the project boundary. Option 1 calculates the emissions based on monitoring the N₂O and CH₄ content in the stack gas. Option 2 calculates the emissions using default emission factors for the amount of N₂O and CH₄ emitted per tonne of fresh waste combusted.

The project adopts Option 2 Using default emission factors

$$PE_{COM_CH4,N2O,c,y} = Q_{waste,c,y} \times (EF_{N2O,t} \times GWP_{N2O} + EF_{CH4,t} \times GWP_{CH4})$$

Where:

$PE_{COM_CH4,N2O,c,y}$ = Project emissions of CH₄ and N₂O from combustion within the project boundary associated with combustor c in year y (t CO₂)

$Q_{waste,c,y}$ = Quantity of fresh waste or RDF/SB fed into combustor c in year y (t)

$EF_{N2O,t}$ = Emission factor for N₂O associated with waste treatment process t (t N₂O/t waste)

$EF_{CH4,t}$ = Emission factor for CH₄ associated with treatment process t (t CH₄/t waste)

GWP_{N2O} = Global Warming Potential of nitrous oxide (t CO₂e/t N₂O)

GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (t CO₂e/t CH₄)

c = Combustor used in the project activity: gasifier, incinerator

t = Type of alternative waste treatment processes: gasification, incineration

5.2. Project emissions from electricity use ($PE_{EC,t,y}$)

The project emissions from electricity consumption due to waste treatment process t implemented under the project activity ($PE_{EC,t,y}$) shall be calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”(TOOL05). When applying the tool:

Note: This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario

or to sources of leakage. The tool only accounts for CO₂ emissions. Grid emission factor is zero for the Ethiopia, so total project emissions from the electricity will be zero

5.3. Project emissions from fossil fuel use ($PE_{FC,t,y}$)

The project emissions from fossil fuel combustion associated with waste treatment process implemented under the project activity ($PE_{FC,t,y}$) shall be calculated using “TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”. According to the tool, the calculation equations are:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FC,j,y}$ = Are the CO₂ emissions from fossil fuel combustion in process j during the year y (tCO₂/yr)

$FC_{i,j,y}$ = Is the quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)

$COEF_{i,y}$ = Is the CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)

i = Are the fuel types combusted in process j during the year y

The PP choose option b according to the Methodology

(b) Option B: The CO₂ emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO₂ emission factor of the fuel type i, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO_2,i,y}$$

Where:

$NCV_{i,y}$ = Is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)

$EF_{CO_2,i,y}$ = Is the weighted average CO₂ emission factor of fuel type i in year y (tCO₂/GJ)

5.4. Project Emissions from wastewater discharge management ($PE_{ww,t,y}$)

Note: If the wastewater discharge is treated in an anaerobic digester, then the associated emissions are calculated according to the section above, “Project emissions from anaerobic digestion”.-TOOL 14

For all calculations and default values refer the Ex-ante excel spreadsheet.

3.3 Leakage

Leakage emissions are as follows:

$$LE_y = LE_{COMP,y} + LE_{AD,y} + LE_{RDF_SB,y}$$

Where:

LE_y = Leakage emissions in the year y (t CO₂e)

$LE_{COMP,y}$ = Leakage emissions from composting or co-composting in year y (t CO₂e)

$LE_{AD,y}$ = Leakage emissions from anaerobic digester in year y (t CO₂e)

$LE_{RDF_SB,y}$ = Leakage emissions associated with RDF/SB in year y (t CO₂e)

In this project activity, there is no composting/co-composting and the use of RDF/SB. Thus, the value $LE_y = LE_{AD,y}$

1.1. Leakage emissions from anaerobic digester ($LE_{AD,y}$)

The leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. They include emissions associated with storage is determined as follows:

$$LE_{AD,y} = LE_{storage,y} + LE_{comp,y}$$

Where:

$LE_{AD,y}$ = Leakage emissions associated with the anaerobic digester in year y (t CO₂e)

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (t CO₂e)

$LE_{comp,y}$ = Leakage emissions associated with composting digestate in year y (t CO₂e)

In this project activity, there is no composting/co-composting. Thus, the value $LE_{AD,y} = LE_{storage,y}$

1.1.2. Determination of leakage emissions associated with storage of digestate ($LE_{storage,y}$)

This step applies in the case that the digestate is stored under the following anaerobic conditions:

- (a) In an un-aerated lagoon that has a depth of more than one meter; or
- (b) In a SWDS, including stockpiles that are considered a SWDS as per the definitions section.

Storage of digestate under anaerobic conditions can cause CH₄ emissions due to further anaerobic digestion of the residual biodegradable organic matter. The procedure for determining $LE_{storage,y}$ is distinguished for liquid digestate.

1.1.3. Determining $LE_{storage,y}$ for liquid digestate

Where digestate is liquid, as per the definitions section of mechanically separated digestate is stored, then choose between Options 2 to determine $LE_{storage,y}$.

Option 2: Procedure using a default value

$$LE_{storage,y} = F_{ww,CH_4,default} \times Q_{CH_4,y} \times GWP_{CH_4}$$

Where:

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (t CO₂e)

$F_{ww,CH_4,default}$ = Default factor representing the remaining methane production capacity of liquid digestate (fraction)

$Q_{CH_4,y}$ = Quantity of methane produced in the digester in year y (t CH₄)

GWP_{CH_4} = Global warming potential of CH₄ (t CO₂ / t CH₄)

3.4 Net GHG emission reductions

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emissions reductions in year y (t CO₂e)

BE_y = Baseline emissions in year y (t CO₂e)

PE_y = Project emissions in the year y (t CO₂e)

LE_y = Leakage emissions in year y (t CO₂e)

Table 8 Emission reductions during the first crediting period

Year	Baseline scenario	Project scenario		Net reduction
	GHG emissions	GHG emissions	Leakage	
Year 1	92,066	55,686	4,661	31,718
Year 2	128,239	55,686	4,661	67,891
Year 3	159,208	55,686	4,661	98,860
Year 4	185,789	55,686	4,661	125,442
Year 5	208,668	55,686	4,661	148,321
Year 6	228,418	55,686	4,661	168,070
Year 7	245,519	55,686	4,661	185,171
Year 8	260,372	55,686	4,661	200,025
Year 9	273,318	55,686	4,661	212,970
Year 10	284,638	55,686	4,661	224,290
Total	1,781,597	501,178	41,952	1,238,467
Average	197,955	55,686	4,661	123,847

4 Legal and documentary aspects

4.1 Legal requirements

Ethiopia has different levels of policy and legislative framework for solid waste management. At the international level, Ethiopia has ratified two international conventions, the Basel Convention in 2000 and the Rotterdam Convention in 2003, to control the transportation and importation of hazardous wastes. At the national level, under the Ethiopian Constitution, which aims to ensure a clean and healthy living environment for citizens, “Environmental Policy in Ethiopia, 1997” was formulated to promote a sustainable society and economy, which became a fundamental basis of waste management in Ethiopia. In addition, other laws and regulations such as the “Criminal Code of the FDRE, 2004” and “Solid Waste Management Proclamation No. 513/2007” have been established to regulate hazardous waste as well as to specify the responsibility of the municipality on waste management. At the level of Addis Ababa City, regulations such as “Regulation No. 100/2018 Revised ISWM Regulation” and “Regulation No. 54/2012 Code Enforcement of Addis Ababa City Government” were formulated to specify the roles and responsibilities of the AACMA and other concerned agencies in waste management, and to establish penalties for waste management violators.

Table 9. Legal requirements

Norm or law	Type (legal, environmental, other)	Applicability/Compliance (total or partial)	Justification
Environmental Policy in Ethiopia, 1997	Environmental	Total	This is the basis on which the solid waste management rules are framed, and the project complies as the objective is management of municipal solid wastes
Solid Waste Management Proclamation No. 513/2007”	Environmental	Total	The project complies as the objective is management of municipal solid wastes
Regulation No. 100/2018 Revised ISWM Regulation” and “Regulation No. 54/2012 Code Enforcement of Addis Ababa City Government”	Environmental	Total	The project complies as the objective is management of municipal solid wastes generated in Addis Ababa.

4.2 Link with NDCs

No link with NDC.

4.3 CCMP documentation

In compliance with *Cercarbono's Protocol for Voluntary Carbon Certification*, the documentation submitted at validation stage are the following:

- ❖ Project Description Document – PDD – The PDD has been submitted
- ❖ Ex-ante ERs calculations spreadsheet – The ex-ante calculation spreadsheet has been submitted. (Confidential)
- ❖ Tool to Report Contributions from Climate Change Mitigation Initiatives to the Sustainable Development Goals.

5 Stakeholder consultation

Before the construction of the project, the methods of local stakeholders participating in consultation mainly include information publicity and questionnaire survey. Through the above methods, the public can view the specific information of the proposed project, raise questions, and give relevant opinions and suggestions.

The relevant stakeholders were identified, and the stakeholder meeting of this project has been conducted on 10th January ,2014. The feedback from the stakeholders was considered.

6 Safeguards

The CCMP complies with the safeguards as set out in the selected methodology and in the Safeguarding Principles and Procedures of Cercarbono's Certification Programme document. The CCMP has identified potential social and environmental risks as per in corresponding risk assessment and has indicated the mitigation plans to address them.

The form Sustainable Development and Safeguards Focus Areas Compliance Statement and related evidence is submitted to validation body. The project activity promotes environmental and socio-economic well-being. Project activity also improves cleanliness in the vicinity and reduces risk of ill health due to solid waste. Thus, there are not any significant impacts due to implementation of project activity on air, water, soil quality and ambience are envisaged due to the project activity.

7 Uncertainty

IPCC default values and the associated discount factors are applied for the relevant parameter as per the guidance in the methodology. The ex-ante calculation sheet is submitted to the validation body.

8 Contributions to the United Nations Sustainable Development Goals

The RWEPP CCMP has been established to avoid methane emissions from open dumping of solid wastes and thus aligns with SDGs and contributes towards sustainability as summarized below:

SDG 3: Health and wellness - The CCMP produces electricity from municipal solid wastes which is dumped in open landfills, due to which diseases spread. Hence the treatment of the waste will reduce the illness to the surrounding population.

SDG 8: Decent Work and Economic Growth - The project creates jobs in waste collection, processing, and energy production, supporting local economies and providing employment opportunities.

SDG 11: Sustainable Cities and Communities - By converting waste into energy, the project helps manage urban waste more effectively, reducing landfill use and promoting cleaner cities.

SDG 13: Climate Action - The project reduces greenhouse gas emissions by diverting waste from landfills and using it to produce energy, thus contributing to climate change mitigation.

The SDG tool has been assessed in accordance with CERCARBONO SDG tool guidance and submitted to the Validation body.

9 Grouped project

It is not a grouped project.

10 CCMP monitoring

10.1 Monitoring plan

Project owner is responsible for overall completeness of data, reliability of data (calibration of meters, weighing machines measuring samples) and monthly report generation. The following shall be measured and recorded:

- i. A gas flow meter installed to measure the amount of biogas before and after upgrading installation.
- ii. The quantity of waste supplied to the plant will be measured by weighing on a weighbridge as described in the Monitoring plan. This information is required for calculation of the ER's.

Data Collection and Archiving:

The plant monitoring staff will implement data reading and periodical recording. The monitoring staff shall implement maintenance, calibration and necessary repair of monitoring equipment. The staff is also responsible for periodical reporting of monitoring result to the manager. The plant manager will check the submitted monitoring report by:

- Record continuously biogas generation and amount of purified biogas generation.
- Record volume of biogas to filling station every day.
- Compare and calculate the data that needs to be measured in the monitoring plan.
- Identify the errors such as typing error and mistakes in digit and unit and made necessary correction.

Data Management:

Data monitored for GHG quantification purposes will be aggregated, summarized, calculated and recorded as an electronic file at the end of every month or year as relevant. All relevant documents such as maps, drawings, applicable standards, monitoring guidance, etc. are systematically stored in order to use to check the appropriateness of data and data management. The collected data and relevant documents will be made available to the verifier so that the reliability of the information can be checked. All the data shall be kept until two (2) years after the end of the credit period.

Quality Assurance and Quality Control:

All monitoring equipment will be maintained and calculated in line with manufacturers' instruction or national standards. Calibration will be implemented according to nationally prescribed standards. These activities will ensure that the equipment operates at the stated level of accuracy.

10.2 Monitoring of GHG emissions in the baseline scenario

Data and parameters fixed ex-ante

Data / Parameter table 10.

Data/Parameter	Φ_{default}								
Data unit	-								
Description	Default value for the model correction factor to account for model uncertainties								
Source of data	Tool to calculate “Emissions from solid waste disposal sites”								
Value(s) applied	0.85								
Choice of data or measurement methods and procedures	For project or leakage emissions: $\Phi_{\text{default}} = 1$. Refer to the following table to identify the appropriate factor based on the application of the tool (A or B) and the climate where the SWDS is located. Default values for the model correction factor								
	<table><tr><td></td><td>Humid/wet conditions</td><td>Dry conditions</td></tr><tr><td>Application A</td><td>0.75</td><td>0.75</td></tr><tr><td>Application B</td><td>0.85</td><td>0.80</td></tr></table>		Humid/wet conditions	Dry conditions	Application A	0.75	0.75	Application B	0.85
	Humid/wet conditions	Dry conditions							
Application A	0.75	0.75							
Application B	0.85	0.80							
Purpose of data	Baseline emissions calculation								
Additional comment	-								

Data / Parameter table 11.

Data/Parameter	f_y
Data unit	0
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
Source of data	Select the maximum value from the following: (a) contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available) and (b) historic data on the amount captured
Value(s) applied	0; In the absence of the project activity there was no capturing and flaring of methane (partially or completely) from the SWDS. Moreover, there is neither any existing contract nor any regulations which require the capture and flaring/destruction of methane (partially or completely) resulting from the SWDS. Hence, $y_f = 0$ for the project activity.

Monitoring frequency	This parameter will be monitored annually.
Measurement methods and procedures	Physical check
QA/QC procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter table 12.

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	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO ₂ . The oxidation factor represents the proportion of methane that is oxidized to CO ₂ . This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data / Parameter table 13.

Data/Parameter	GWP_{CH4}
Data unit	t CO ₂ e/t CH ₄
Description	Global Warming Potential of methane valid for the commitment period (t CO ₂ e/t CH ₄)
Source of data	IPCC
Value(s) applied	Default value of 27 from IPCC sixth Assessment Report (AR6).
Choice of data or measurement methods and procedures	-
Additional comment	-

Data / Parameter table 14.

Data/Parameter	F
Data unit	Volume fraction
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	2006 IPCC Guidelines for National Greenhouse Gas Inventories is a reliable data source.
Purpose of data	Baseline emissions calculation
Additional comment	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide.

Data / Parameter table 15.

Data/Parameter	DOC_{f,default}
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	According to the tool, this default value can be used for Application B if the tool is applied to MSW.
Purpose of data	Baseline emissions calculation
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can only be used for: (a) Application A; or (b) Application B if the tool is applied to MSW

Data / Parameter table 16.

Data/Parameter	DOC_j
Data unit	Weight fraction
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value(s) applied	Refer the Ex-ante excel sheet

Choice of data or measurement methods and procedures	For MSW, the following values for the different waste types j should be applied: Default values for DOC _j													
	<table> <tr> <th>Waste type j</th><th>DOC_j (% wet waste)</th></tr> <tr> <td>Wood and wood products</td><td>43</td></tr> <tr> <td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr> <tr> <td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr> <tr> <td>Textiles</td><td>24</td></tr> <tr> <td>Garden, yard and park waste</td><td>20</td></tr> <tr> <td>Glass, plastic, metal, other inert waste</td><td>0</td></tr> </table>	Waste type j	DOC _j (% wet waste)	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
Waste type j	DOC _j (% wet waste)													
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													
	In this project, only MSW is processed, so the default values for each waste types j in the table above are applied.													
Purpose of data	Baseline emissions calculation													
Additional comment	The procedure for the ignition loss test is described in BS EN 15169:2007 Characterization of waste. Determination of loss on ignition in waste, sludge and sediments. The percentages listed in the table above are based on wet waste basis which are concentrations in the waste as it is delivered to the SWDS. The IPCC Guidelines also specify DOC values on a dry waste basis, which are the concentrations after complete removal of all moist from the waste, which is believed not practical for this project situation													

Data / Parameter table 17.

Data/Parameter	MCF_{default}
Data unit	-
Description	Methane correction factor
Source of data	TOOL04
Value(s) applied	In case that the SWDS does not have a water table above the bottom of the SWDS and in case of application A, then select the applicable value from the following: (a) 1.0 for anaerobic managed solid waste disposal sites. These must have 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 will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste; (b) 0.5 for semi-aerobic managed solid waste disposal sites. These must have controlled placement of waste and will include all of the following structures for introducing air to the waste layers: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system; (c) 0.8 for unmanaged solid waste disposal sites – deep. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters; (d) 0.4 for unmanaged-shallow solid waste disposal sites or stockpiles that are considered SWDS. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than five meters. This includes stockpiles of solid waste that are considered SWDS (according to the definition given for a SWDS) (a) 1.0 for anaerobic managed solid waste disposal sites is applicable to this project.
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	MCF accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS. In case of a water table above the bottom of the SWDS, a larger proportion of the SWDS is anaerobic and MCF shall be estimated

Data / Parameter table 18.

Data/Parameter	k_j
Data unit	1/yr
Description	Decay rate for the waste type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	Apply the following default values for the different waste types j: Default values for the decay rate (k_j)

	Waste type j		Boreal and Tem- perate (MAT≤20°C)		Tropical (MAT>20°C)	
			Dry (MAP/ PET<1)	Wet (MAP/P ET >1)	Dry (MAP< 1000m m)	Wet (MAP > 1000 mm)
	Slowly degrad- ing	Pulp, pa- per, card- board (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
	Mo- drately degrad- ing	Other (non- food) or- ganic pu- trescible garden and park waste	0.05	0.10	0.065	0.17
Rapidly degrad- ing	Food, food waste, sewage sludge, beverages and to- bacco	0.06	0.185	0.085	0.40	

Note: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.

If a waste type disposed of in a SWDS cannot clearly be attributed to one of the waste types in the table above, project participants should choose, among the waste types that have similar characteristics, the waste type where the values of DOCj and kj result in a conservative estimate (lowest

	emissions) or request a revision of/deviation from this methodology. In the case of EFB, as their characteristics are similar to garden waste, the parameter values correspondent of garden waste shall be used. In case of sludge from pulp and paper industry, a conservative value of 0.03 shall be used for all precipitation and temperature combinations
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	Document in the climatic conditions at the SWDS site (temperature, precipitation and, where applicable, evapotranspiration).

Data / Parameter table 19.

Data/Parameter	Rate_{compliance}
Data unit	Fraction
Description	State level compliance rate of the MSW Management Rules in that year y
Source of data	Preferably from secondary sources like government report
Value(s) applied	0
Monitoring frequency	Annual
Measurement methods and procedures	-
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.

Data / Parameter table 20.

Data/Parameter	W_{j,x}
Data unit	t
Description	Total amount of waste that is avoided from being treated in landfills in year y
Source of data	Plant records
Value(s) applied	420,000t/yr
Monitoring frequency	Continuous with annual aggregation
Measurement methods and procedures	-

QA/QC procedures	Regular weighing of waste by project proponent will be carried out in a weighbridge according to Monitoring plan. The weigh bridge would be calibrated annually
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter table 21.

Data/Parameter	W_x		
Data unit	t		
Description	Total amount of solid waste disposed of or prevented from disposal in the SWDS in year x (t)		
Source of data	Plant records		
Value(s) applied	W _x	Percentage of waste received	Compositions based on percentages
	Food waste	52.80%	221,760
	Paper	5.00%	21,000
	Textiles	2.20%	9,240
	Plastics	9.60%	40,320
	Glass-ceramics	1.30%	5,460
	Metal	1.30%	5,460
	Garden, yard and park waste	10.30%	43,260
	wood	3.00%	12,600
	Diapers & sanitary napkins	7.10%	29,820
	Others(Ash/fine waste and Miscellaneous)	7.40%	31,080
	Total	100%	420,000
Monitoring frequency	-		
Measurement methods and procedures	-		
Purpose of data	Calculation of baseline emissions		

10.3 Monitoring of GHG emissions and GHG emission reductions in the project scenario

Data and parameters fixed ex-ante:

Data / Parameter table 22.

Data/Parameter	$p_{n,j,y}$																								
Data unit	Weight fraction																								
Description	Weight fraction of the waste type j in the sample n collected during the year y																								
Source of data	IPCC																								
Value(s) applied	Refer the table																								
Monitoring frequency	-																								
Measurement methods and procedures	Sample the waste composition, using the waste types j, as provided in the table for DOC_j and k_j, and weight each waste fraction (measure on wet basis) <table border="1"> <thead> <tr> <th>Type of Waste J</th><th>$P_{n,j,y,dry}$ Proportion of dry weight (%)</th></tr> </thead> <tbody> <tr> <td>Food waste</td><td>62.50%</td></tr> <tr> <td>Paper/cardboard</td><td>8.50%</td></tr> <tr> <td>Nappies</td><td>2.50%</td></tr> <tr> <td>Textiles</td><td>3.00%</td></tr> <tr> <td>Rubber & Leather(Including Building materials)</td><td>1.50%</td></tr> <tr> <td>Garden & Park Waste</td><td>5%</td></tr> <tr> <td>Wood</td><td>1.00%</td></tr> <tr> <td>Plastics</td><td>5.00%</td></tr> <tr> <td>Metal</td><td>2.00%</td></tr> <tr> <td>Glass</td><td>1.50%</td></tr> <tr> <td>Other(Ash/fine waste and Miscellaneous)</td><td>7.50%</td></tr> </tbody> </table>	Type of Waste J	$P_{n,j,y,dry}$ Proportion of dry weight (%)	Food waste	62.50%	Paper/cardboard	8.50%	Nappies	2.50%	Textiles	3.00%	Rubber & Leather(Including Building materials)	1.50%	Garden & Park Waste	5%	Wood	1.00%	Plastics	5.00%	Metal	2.00%	Glass	1.50%	Other(Ash/fine waste and Miscellaneous)	7.50%
Type of Waste J	$P_{n,j,y,dry}$ Proportion of dry weight (%)																								
Food waste	62.50%																								
Paper/cardboard	8.50%																								
Nappies	2.50%																								
Textiles	3.00%																								
Rubber & Leather(Including Building materials)	1.50%																								
Garden & Park Waste	5%																								
Wood	1.00%																								
Plastics	5.00%																								
Metal	2.00%																								
Glass	1.50%																								
Other(Ash/fine waste and Miscellaneous)	7.50%																								
QA/QC procedures	-																								
Purpose of data	Project emissions calculation																								
Additional comment	This parameter only needs to be monitored for Application B and if the waste includes more than one waste type j. Sampling is not required if the waste comprises only one waste type																								

Data / Parameter table 23.

Data/Parameter	$Q_{j,c,y \text{ dry}}$
Data unit	T
Description	Quantity of fresh waste type j fed into combustor c the in year y (t)
Source of data	Feasability study report(FSR)

Value(s) applied	Waste Type	Qj,c,y, Dry Weight of waste (tons)
	Food waste	125,213
	Paper/cardboard	17,029
	Nappies	5,009
	Textiles	6,010
	Rubber & Leather(Including Building materials)	3,005
	Garden & Park Waste	10,017
	Wood	2,003
	Plastics	10,017
	Metal	4,007
	Glass	3,005
	Other(Ash/fine waste and Miscellaneous)	15,026
	Total	200,340
Monitoring frequency	calculated	
QA/QC Procedures	Measured annually	
Purpose of data	Project emissions calculation	
Additional comment	-	

Data / Parameter table 24.

Data/Parameter	FFC_j
Data unit	%
Description	Fraction of fossil carbon in total carbon content of waste type j
Source of data	Table 2.4, chapter 2, volume 5 of IPCC 2006 guidelines

Value(s) applied	For MSW the following values for the different waste types j may be applied: Table for Default values for $FFC_{j,y}$ <table> <tr> <th>Waste type j</th><th></th></tr> <tr> <td>Paper/cardboard</td><td>5</td></tr> <tr> <td>Textiles</td><td>50</td></tr> <tr> <td>Food waste</td><td>-</td></tr> <tr> <td>Wood</td><td>-</td></tr> <tr> <td>Garden and Park waste</td><td>0</td></tr> <tr> <td>Nappies</td><td>10</td></tr> <tr> <td>Rubber and Leather</td><td>20</td></tr> <tr> <td>Plastics</td><td>100</td></tr> <tr> <td>Metal*</td><td>NA</td></tr> <tr> <td>Glass*</td><td>NA</td></tr> <tr> <td>Other, inert waste</td><td>100</td></tr> </table> *Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common.	Waste type j		Paper/cardboard	5	Textiles	50	Food waste	-	Wood	-	Garden and Park waste	0	Nappies	10	Rubber and Leather	20	Plastics	100	Metal*	NA	Glass*	NA	Other, inert waste	100
Waste type j																									
Paper/cardboard	5																								
Textiles	50																								
Food waste	-																								
Wood	-																								
Garden and Park waste	0																								
Nappies	10																								
Rubber and Leather	20																								
Plastics	100																								
Metal*	NA																								
Glass*	NA																								
Other, inert waste	100																								
Choice of data or measurement methods and procedures	-																								
Purpose of data	Calculation of project emission																								
Additional comment	Data and parameters to be monitored in respect of the balance method are shown in the Appendix 2 additionally																								

Data / Parameter table 25.

Data/Parameter	FCC_j																
Data unit	%																
Description	Fraction of total carbon content in waste type j																
Source of data	Table 2.4, chapter 2, volume 5 of IPCC 2006 guidelines																
Value(s) applied	For MSW the following values for the different waste types j may be applied: Table for Default values for $FCC_{j,y}$ <table> <tr> <th>Waste type j</th><th></th></tr> <tr> <td>Paper/cardboard</td><td>50</td></tr> <tr> <td>Textiles</td><td>50</td></tr> <tr> <td>Food waste</td><td>50</td></tr> <tr> <td>Wood</td><td>54</td></tr> <tr> <td>Garden and Park waste</td><td>55</td></tr> <tr> <td>Nappies</td><td>90</td></tr> <tr> <td>Rubber and Leather</td><td>67</td></tr> </table>	Waste type j		Paper/cardboard	50	Textiles	50	Food waste	50	Wood	54	Garden and Park waste	55	Nappies	90	Rubber and Leather	67
Waste type j																	
Paper/cardboard	50																
Textiles	50																
Food waste	50																
Wood	54																
Garden and Park waste	55																
Nappies	90																
Rubber and Leather	67																

	Plastics	85
	Metal*	NA
	Glass*	NA
	Other, inert waste	5
	*Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common	
Choice of data or measurement methods and procedures		
Purpose of data		
Additional comment	Data and parameters to be monitored in respect of the balance method are shown in the Appendix 2 additionally	

Data / Parameter table 26.

Data/Parameter	EFF_{COM,c,y}
Data unit	%
Description	Combustion efficiency of combustor c in year y.
Source of data	Specific data related to project activities.
Value(s) applied	100%
Monitoring frequency	Each year
Measurement methods and procedures	Measured according to industry standards by a qualified third party.
QA/QC procedures	-
Purpose of data	Calculate the project emissions
Additional comment	-

Data / Parameter table 27.

Data/Parameter	Q_{waste,c,y}
Data unit	T
Description	Quantity of fresh waste fed into Incinerator in year y
Source of data	Feasability study report(FSR)
Value(s) applied	420,000
Monitoring frequency	Continuously
Measurement methods and procedures	Measured with calibrated scales or load cells
QA/QC procedures	The crane shall be calibrated as per manufacturer's specification
Purpose of data	Project emissions calculation
Additional comment	- Data shall be aggregated at least annually

Data / Parameter table 28.

Data/Parameter	GWP_{N2O}
Data unit	tCO ₂ e/tN ₂ O
Description	Global warming potential of N ₂ O
Source of data	IPCC AR6
Value(s) applied	273
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of project emission
Additional comment	-

Data / Parameter table 29.

Data/Parameter	EF_{CH₄,t}
Data unit	t CH ₄ /t waste (wet basis)
Description	Emission factor for CH ₄ associated with waste treatment process t
Source of data	ACM0022
Value(s) applied	0.000000242

Choice of data or measurement methods and procedures	If country-specific data is available, then this shall be applied and the method used to derive the value as well as the data sources need to be documented in the CDM-PDD. If country-specific data are not available, then apply the default values listed in Table 6. For continuous incineration of industrial waste, apply the CH4 emission factors provided in Volume 2, Chapter 2, Stationary Combustion of IPCC 2006 Guidelines.			
	Table . CH4 emission factors for combustion			
	Waste type	Type of incineration/technology	CH4 emission factors (t CH4 / t waste) wet basis	
	MSW	Continuous incineration	stoker	1.21x 0.2x10 ⁻⁶
			fluid-ised bed	~0
		Semicontinuos incineration	stoker	1.21x 6x10 ⁻⁶
			fluid-ised bed	1.21x 188x10 ⁻⁶
		Batch type incineration	stoker	1.21x 60x10 ⁻⁶
			fluid-ised bed	1.21x 237x10 ⁻⁶
	Sludge(semi-continues or batch type Incineration)		1.21x 9 700x10 ⁻⁶	
	Waste oil (semi-continuous or batch type incineration)		1.21x 560x10 ⁻⁶	
A conservativeness factor of 1.21 has been applied to account for the uncertainty of the IPCC default values				
Purpose of data	Calculation of project emission			
Additional comment	Applicable to Option 2 of procedure to estimate PE _{COM,c,y}			

Data / Parameter table 30.

Data/Parameter	EF_{N2O,t}
Data unit	t N2O/t waste (wet basis) or Fraction
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data	Table 5.6, chapter 5, volume 5 of IPCC 2006 guidelines-ACM0022
Value(s) applied	0.0000605

Choice of data or measurement methods and procedures	If country-specific data is available, then this shall be applied, and the method used to derive the value as well as the data sources need to be documented in the CDM-PDD. If country specific data are not available, then apply the default values listed in below Table		
	Table for N₂O emission factors for combustion		
	Type of waste	Technology / Management practice	Emission factor (t N ₂ O/t waste wet basis)
	MSW	Continuous and semi-continuous incinerators	1.21x 50x10 ⁻³
	MSW	Batch-type incinerators	1.21x 60x10 ⁻³
	Industrial waste	All types of incineration	1.21x 100x10 ⁻³
	Sludge (except sewage sludge)	All types of incineration	1.21x 450x10 ⁻³
Purpose of data	Sewage sludge	Incineration	1.21x 900x10 ⁻³
	A conservativeness factor of 1.21 has been applied to account for the uncertainty of the IPCC default values		
Purpose of data	Calculation of project emissions		
Additional comment	Applicable to Option 2, of procedure to estimate PE _{COM,c,y}		

Data / Parameter table 31.

Data/Parameter	FC_{i,j,y}
Data unit	t/year
Description	Is the quantity of fuel type i combusted in process j during the year y
Source of data	Monitored and measured in the project site.
Value(s) applied	350t
Monitoring frequency	Measuring when consumption happens.
Measurement methods and procedures	-
QA/QC procedures	The amount of auxiliary fuel and ignition fuel should be checked with the raw material account.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter table 32.

Data/Parameter	NCV_{i,y}
Data unit	GJ/t
Description	Net caloric value of the fuel used in the project
Source of data	Volume-2;Table-1.2:DEFAULT NET CALORIFIC VALUES (NCVs) of 2006 IPCC Guidelines for National greenhouse Gas Inventories;Page-18
Value(s) applied	43
Choice of data or measurement methods and procedures	The readings of electricity meter will be aggregated monthly and annually and archived during the crediting period and two years after.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter table 33.

Data/Parameter	EF_{CO2,i,y}
Data unit	tCO ₂ /GJ
Description	Weighted average CO ₂ emission factor of fuel type i in year y
Source of data	Volume-2;Table-1.4:Default CO ₂ emission factors for combustion of 2006 IPCC Guidelines for National greenhouse Gas Inventories;Page-23
Value(s) applied	0.0741
Choice of data or measurement methods and procedures	For (a) and (b):Measurements should be undertaken in line with national or international fuel standards
Purpose of data	Calculate project emission
Additional comment	Applicable where option B is used. For (a): If the fuel supplier does provide the NCV value and the CO ₂ emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO ₂ factor should be used. If another source for the CO ₂ emission factor is used or no CO ₂ emission factor is provided, Options (b), (c) or (d) should be used

Data / Parameter table 34.

Data/Parameter	COEF_{i,y}
Data unit	tCO ₂ /mass or volume
Description	Is the CO ₂ emission coefficient of fuel type i in year y (tCO ₂ /mass or volume unit)

Source of data	Volume-2;Table-1.4:Default CO ₂ emission factors for combustion of 2006 IPCC Guidelines for National greenhouse Gas Inventories;Page-23
Value(s) applied	$NCV_{i,y} * EF_{CO_2,l,y}$
Choice of data or measurement methods and procedures	-
Purpose of data	Calculate project emission
Additional comment	-

Data / Parameter table 35.

Data/Parameter	$Q_{biogas,y}$
Data unit	Nm ³ biogas
Description	Amount of biogas collected at the digester outlet in year y
Source of data	Project study report
Value(s) applied	2,863,060 7844 biogas per day*365 days
Monitoring frequency	Annually
Purpose of data	Calculate project emission
Additional comment	-

Data / Parameter table 36.

Data/Parameter	$f_{CH_4,default}$
Data unit	m ³ CH ₄ / m ³ biogas corrected to reference conditions
Description	Default value for the volumetric fraction of methane in biogas
Source of data	The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)
Value(s) applied	0.6
Monitoring frequency	-
Purpose of data	Calculate project emission
Additional comment	Use this value for Option 2 of the step “Determination of the quantity of methane produced in the digester”

Data / Parameter table 37.

Data/Parameter	ρ_{CH_4}
Data unit	t CH ₄ / m ³ CH ₄
Description	Density of methane at reference conditions
Source of data	Calculated applying TOOL08
Value(s) applied	0.00067

Purpose of data	Calculate project emission
Additional comment	-

Data / Parameter table 38.

Data/Parameter	$Q_{CH_4,y}$
Data unit	tCO ₂ e
Description	Quantity of methane produced in the anaerobic digester in year y
Source of data	Calculated
Value(s) applied	1,151
Choice of data or measurement methods and procedures	-
Purpose of data	Calculate project and Leakage emission
Additional comment	-

Data / Parameter table 39.

Data/Parameter	$EF_{CH_4,default}$
Data unit	t CH ₄ leaked / t CH ₄ produced
Description	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester
Source of data	IPCC (2006), IPCC(2019), Flesch et al. (2011) and Kurup (2003)
Value(s) applied	Use the default value corresponding to the type of digester used in the project activity. The digester type shall be identified by manufacturer information. If this is not possible, then the factor 0.1 shall be applied (upper range of the IPCC values). • 0.028: Digesters with steel or lined concrete or fiberglass digesters and a gas holding system (egg shaped digesters) and monolithic construction. • 0.05: UASB type digesters, floating gas holders with no external water seal; • 0.10: Digesters with unlined concrete/ferrocement/brick masonry arched type gas holding section; monolithic fixed dome digesters, covered anaerobic lagoon. 0.028 is applicable to this project
Purpose of data	Calculate project emission
Additional comment	Applicable to the step “Determination of project emissions of methane from the anaerobic digester”

Data / Parameter table 40.

Data/Parameter	$Q_{ww,y}$
Data unit	tCO ₂ e
Description	Amount of wastewater discharge generated by the project activity and treated anaerobically or released untreated from the project activity in year y
Source of data	FSR
Value(s) applied	57092.5
Choice of data or measurement methods and procedures	-
Purpose of data	Calculate project emission
Additional comment	-

Data / Parameter table 41.

Data/Parameter	$P_{cod,y}$
Data unit	tCOD/m ³
Description	COD of the wastewater discharge generated by the project activity in year y
Source of data	FSR
Value(s) applied	0.0168
Monitoring frequency	Monthly and averaged annually
Measurement methods and procedures	-
QA/QC procedures	The monitoring instruments will be subject to regular maintenance and testing to ensure accuracy.
Purpose of data	Calculation of project emissions
Additional comment	If the wastewater discharge is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored

Data / Parameter table 42.

Data/Parameter	B_o
Data unit	t CH ₄ /tCOD
Description	Maximum methane producing capacity
Source of data	TOOL14
Value(s) applied	0.25
Choice of data or measurement methods and procedures	-

Purpose of data	Calculation of project emissions
Additional comment	Applicable to the “Procedure to calculate project emissions from wastewater treatment”

Data / Parameter table 43.

Data/Parameter	MCF_{ww}
Data unit	Fraction
Description	Methane conversion factor for wastewater treatment
Source of data	Table 6.3, chapter 6, volume 5 from IPCC 2006 guidelines
Value(s) applied	1.0
Choice of data or measurement methods and procedures	Default value
Purpose of data	Calculate project emission related to wastewater treatment
Additional comment	-

Data / Parameter table 44.

Data/Parameter	$\eta_{\text{flare},m}$
Data unit	-
Description	Flare efficiency in the minute m
Source of data	TOOL06
Value(s) applied	0.5
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of project emissions
Additional comment	-

Leakage Emissions

i) Ex-ante parameters:

Data / Parameter table 45.

Data/Parameter	F_{ww,CH4,default}
Data unit	Fraction
Description	Default factor representing the remaining CH ₄ production capacity of liquid digestate
Source of data	Reference papers and current industry practice
Value(s) applied	• 0.10: Covered anaerobic lagoons;

	• 0.15: UASB type digesters / Anaerobic filter bed digesters / Anaerobic fluidized bed digesters; • 0.20: Conventional digesters; • 0.05: Two stage digesters 0.15 is applicable to this project
Choice of data or measurement methods and procedures	
Purpose of data	Calculation of Leakage emissions
Additional comment	

Data / Parameter table 46.

Data/Parameter	LE_{storage,y}
Data unit	tCO ₂ e
Description	Leakage emissions associated with storage of digestate in year y
Source of data	Calculation
Value(s) applied	Calculated
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of Leakage emissions
Additional comment	-

11 Information management

Data Management:

Data monitored for GHG quantification purposes will be aggregated, summarized, calculated and recorded as an electronic file at the end of every month or year as relevant. All relevant documents such as maps, drawings, applicable standards, monitoring guidance, etc. are systematically stored in order to use to check the appropriateness of data and data management. The collected data and relevant documents will be made available to the verifier so that the reliability of the information can be checked. All the data shall be kept until two (2) years after the end of the credit period.

Quality Assurance and Quality Control:

All monitoring equipment will be maintained and calibrated in line with manufacturers' instruction or national standards. Calibration will be implemented according to nationally prescribed standards. These activities will assure that the equipment operates at the stated level of accuracy.

12 References

CERCARABONO (2024). Cercarbono's Protocol for Voluntary Carbon Certification. V4.4

<https://www.cercarbono.com/wp-content/uploads/Cercarbonos-Protocol-V-4.4.pdf>

ACM0022: Alternative waste treatment processes

<https://cdm.unfccc.int/UserManagement/FileStorage/61X9DPNL7G4Y5JMB3CKFHUSREO2QVI>

TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf>

TOOL04: Emissions from solid waste disposal sites

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.1.pdf>

TOOL06: Project emissions from flaring

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v4.0.pdf>

TOOL14: Project and leakage emissions from anaerobic digesters

<https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v3.pdf>

13 Document history(PDD)

Version	Date	Comments or editions
1.0	30.11.2024	Initial version of the document submitted for validation
2.0	23.04.2025	Final Version of the document submitted for validation

14 Template history

Version	Date	Comments or changes
1.0	30.10.2019	Initial version.
2.0	11.01.2022	Redesign to give more relevance to the institution developing the CCMP and to adjust to the new version of the Protocol.
3.0	01.08.2022	Content adjustments and editorial changes.
3.1	03.09.2024	Notes incorporated based on <i>Safeguarding Principles and Procedures of Cercarbono's Certification Programme</i> document update.