

Joint Validation and Verification Report for CCMP in Sectors Other Than Land Use

CCMP name	Avoidance of methane emission from Municipal Solid Waste project in Ethiopia
Client	Kanaka Management Services Private Limited
CCMP ID	238
Report ID	ESSPL/CER/2023/011
Verification number	1
Audit criteria	The purpose of the validation and verification is to perform an independent, third-party assessment of whether the CCMP confirms to the qualification criteria set in the Cercarbono's Protocol for Voluntary Carbon Certification 4.4 requirements to attain real, measurable, additional and permanent emission reduction.
Methodology	Large-scale Consolidated Methodology: Alternative waste treatment processes, version 3.0 (ACM0022)

Duration of the CCMP		From 01-Jan-2020 to 31-Dec-2049
Area, facility, or process validated and verified		Total area of the facility is 39 hectares
Validated accreditation period		From 01-Jan-2020 to 31-Dec-2029.
Period of verification		From 01-Jan-2020 to 31-Dec-2024
Validation	Total GHG emission reductions generated in the crediting period	2,066,235
	Net GHG emission reductions generated in the credited period	1,462,757
Verification	Total GHG emission reductions generated in the verified period	466,922
	Net GHG emission reductions generated in the verified period	346,820
Date of preparation of validation and verification report		16-Apr-2025
Document prepared by		EPIC Sustainability Services Private Limited
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Acronyms and abbreviations

CCMP	Climate Change Mitigation Programme or Project
GHG	Greenhouse Gases
NDCs	Nationally Determined Contribution
PDD	Project Description Document
MR	Monitoring Report
RWEP	Reppie Waste-to-Energy Project
SDGs	Sustainable Development Goals
VVB	Validation and Verification Body
PP	Project Proponent

Introduction

1.1 Objective

Kanaka Management Services Private Limited (herein after referred to as KMS) contracted EPIC Sustainability Services Private Limited (herein after referred to as EPIC) to undertake joint validation and verification of the project activity titled " Avoidance of methane emission from Municipal Solid Waste project in Ethiopia" with ID 238 (hereinafter referred as CCMP). The objective of this joint validation and verification is to conduct an independent third-party assessment.

- Review and assess the project design document to ensure it aligns with Cercarbono's Protocol for Voluntary Carbon Certification v4.4^{/1/} and Procedures of Cercarbono's Certification Programme v2.2^{/2/}.
- Evaluate the project activity and quantify carbon emissions reductions to confirm its accuracy and appropriateness.
- Verify the compliance of project activity with applied methodology ACM0022^{/4/}.
- Examine the data collected by the project developer to ensure it is accurate, complete, and consistent with the project design.
- Check data quality control procedures to verify data integrity.
- Assess whether the project's carbon reductions or removals would not have occurred in the absence of the project.
- Evaluate the project's contribution to additional climate mitigation beyond business-as-usual scenarios.
- Review the project's environmental and social impact assessment to identify potential risks and benefits.
- Assess the project's compliance with relevant environmental and social standards.
- Evaluate the project's monitoring system to ensure it is robust and reliable.
- Prepare a joint statement confirming the project's compliance with Cercarbono's guidelines and protocols.

1.2 VVB legal status

EPIC Sustainability is a private limited organization incorporated under the Companies Act, 1956 amended by Republic of India, on 8th November 2010. EPIC is located in Bengaluru, Karnataka. EPIC operates solely from its headquarters in Bengaluru, India, without any branch offices or outsourced validation and verification services

EPIC is a DOE accredited by UNFCCC for conducting validation and verification with accreditation period from 28 November 2023 - 27 November 2028 (<https://cdm.unfccc.int/DOE/list/DOE.html?entityCode=E-0062>). Based on this UNFCCC accreditation, EPIC is qualified to validate and verify the proposed project activity in the waste management sector under the CerCarbono framework. (<https://www.cercarbono.com/validation-and-verification/>)

The company is jointly owned by Mr. R. B. Venkataramanaiah and Ms. Sarala.

1.3 Impartiality of the VVB

EPIC, as an independent third-party evaluator, upholds impartiality in all its services. To guarantee this, EPIC has established rigorous internal procedures and a quality manual. These procedures ensure impartiality at the policy, organizational, and operational levels.

To mitigate potential conflicts of interest, EPIC assesses the familiarity risk of personnel involved in validation or verification activities. Each audit team member discloses any prior engagement with the project developer or consultant. The head of operations evaluates this risk and categorizes it as low, medium, or high based on internal procedures. Audit teams are assigned only if the risk is low or medium, with appropriate measures in place.

The team members have confirmed the absence of any conflict of interest between themselves and the CCMP holder. EPIC further confirms that no conflict of interest exists between its management, the project team members, and the CCMP holder.

1.4 Responsibilities addressed by the VVB

As part of its management system, EPIC evaluates the risks arising from the joint validation and verification activity from the beginning of the technical-commercial relationship process with the CCMP holder. Additionally, EPIC has a comprehensive insurance policy of five million USD, to cover the liabilities arising from validation and verification activities in the geographic areas in which it operates.

1.5 Scope and spatial and temporal limits

The CCMP is categorized as two types under Cercarbono, based on the amount of GHG emissions reduced by a CCMP during the crediting period as following;

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

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

The CCMP achieves an estimated amount of 132,978 tCO₂e per year, therefore, it is categorized as type 1 project. The same was confirmed by reviewing the Ex-ante and Ex-post Emission reduction calculation sheet.

The CCMP holder has applied CDM approved methodology ACM0022 version 3.0^{4/}, which is appropriate to apply in accordance with the CCMP type.

The Project activity is located in Kolfe Keranio sub-city of Addis Ababa, Ethiopia. The geo-coordinates of the CCMP is 8°58'34"N / 38°42'35"E. The VVB checked the geo-coordinates of the Project site in Google earth pro, reviewed KML file submitted by the CCMP holder and verified the same during the site visit. The CCMP is a stand alone project located only in Ethiopia.

The CCMP falls under sectoral area Waste management as it is a CCMP type 1 project and involves incineration of the municipal solid waste, by which emission of methane is avoided. The CCMP is constructed in 53,120 m² area. The VVB reviewed the Project Completion Report^{13/} issued by Japan International Cooperation Agency (JICA), Kokusai Kogyo Co., Ltd. And Final Design – Project General Specification prepared by China National Electric Engineering Co., Ltd (CNEEC) and Cambridge Industries Limited (CIL) to confirm the technology and area of the facility used in the CCMP.

1.6 Term of commitment

EPIC has been contracted by KMS to conduct joint validation and verification of the proposed CCMP in accordance with the requirements set forth in Cercarbono protocol version 4.4.

EPIC conducts these validation and verification activities in line with its code of ethics and internal procedures, adhering to the guidelines of ISO 14064-2 standard.

EPIC focuses on identifying and mitigating significant risks during the validation and verification process. These activities are carried out independently to ensure impartiality and provide a reasonable level of assurance on the CCMP. All information related to the CCMP and its holders is kept confidential as per internal procedures. EPIC does not offer consulting or recommendations to the CCMP holder. However, requests for clarifications and/or corrective actions may provide input for improving monitoring activities.

1.7 Level of assurance and materiality

The assurance level is 95% (reasonable assurance) for the issued joint validation and verification statement, contractually agreed between KMS and EPIC. The sources of information used throughout this evaluation by the audit team have been considered reliable, which are, among others: the PDD and the MR, the on-site inspection, the interviews carried out, the review of documentation and secondary sources of information. This has allowed us to obtain a reasonable level of assurance in accordance with the provisions of the Cercarbono Protocol. It has been guaranteed that the material discrepancy obtained is less than 5%.

2 Validation and verification process

2.1 Validation and verification plan

Validation and verification:

The EPIC joint validation and verification process is divided into the following stages:

- Review of the project description and the monitoring parameters in documents
- Interviews with the project developer, project consultant, and other essential stakeholders through onsite audit.
- Final joint validation and verification report preparation and opinion.

A validation methodology was created for the project according to the CERCARBONO rules to ensure transparency. The protocol transparently defines the findings, criteria (requirements), validation methods, validation outcomes, and how the stated criteria(s) are met. The validation protocol is used to accomplish the following goals:

- It ensures a transparent validation process by documenting how a particular requirement has been validated as well as the result of the validation.

EPIC validation and verification process applies the risk-based approach aimed at focusing on high-risk issues to the validation results whilst not omitting any part of the mandatory processes. A few discrepancies were found during the validation and the validation report was submitted to the project proponent, indicated under the titles corrective action requests (CARs) and clarification requests (CLs). CARs and CLs require the PP to take relevant actions. Criteria for judging items as CAR or CL are as follows:

Corrective action request (CAR):

- The project participant has made a mistake that will influence the ability of the project activity to achieve real, measurable additional emission reductions.

- The CERCARBONO's requirements have not been met, or
- There is a risk that the Emission Reductions cannot be monitored or calculated.

Clarification Request (CL):

- Information is insufficient or not sufficiently clear to determine whether the applicable CERCARBONO requirements have been met.

The validation team raised 01 "Clarification Request" and 07 "Corrective Action Requests" (CARs), indicating that further information is required to completely resolve an issue.

2.2 Assessment criteria

The joint validation and verification of the CCMP is assessed in accordance with the below criteria;

- Cercarbono's Protocol for Voluntary Carbon Certification version 4.4
- Procedures of Cercarbono's Certification Programme version 2.2
- Terms and Definitions of the Voluntary Certification Programme of Cercarbono version 3.1
- Applied methodology: ACM0022 Alternative waste treatment processes version 2.0 and its associated tools.
- Applied tools:
 - Tool to demonstrate additionality of Climate Change Mitigation Initiatives version 2.0.1
 - Tool to Report Contributions from Climate Change Mitigation Initiatives to the Sustainable Development Goals version 1.3
- Host country regulations.
- ISO 14064.

2.3 Evidence collection plan

The validation of the documentation related to the aggregated project submitted by the holder is based on quantitative and qualitative data on the implementation of the reference requirements mentioned in section 2.2 of this report. The statistics stated in the PDD v2.0^{7/} are included in the quantitative information, while the qualitative material includes internal management controls, calculating techniques, and the socio-environmental implications of the project.

To ensure that the assertions of the holder of the grouped project in their documentation are credible, traceable, and reliable, the information supplied by the holder of the grouped project contrasted with primary and secondary information sources.

In addition to the review described in the preceding paragraphs, the offsite assessment and interviews significantly assisted the validation team in gathering tests and evidence that provided robustness to the evaluation process.

2.4 CCMP site or area visits

The project details, eligibility criteria, baseline, monitoring practices adopted and followed for the operation of the project and environment impact aspects were examined on 28th and 29th January 2025.

An onsite assessment was conducted as a part of validation and verification activity and involved:

1. An assessment of the implementation and operation of the project activity as per the PDD.
2. Interviews with relevant personnel to confirm that the operational and data collection procedures are implemented in accordance with the PDD.
3. A Cross-check between information provided in the PDD, MR and data from other sources.
4. A review of the baseline of the project.
5. A check of the monitoring and observations of monitoring practices against the requirements of the PDD, MR and the applied methodology.
6. A review of calculations and assumptions made in determining the GHG data and ERs.
7. An identification of QA/QC procedures in place to prevent, or identify and correct, any errors or omissions in the reported monitoring parameters.
8. Ownership of CCMP and start date of the project.

2.5 Requests required by the VVB

The findings, non-conformities of the project against the standard requirements, national regulations etc., have been raised as CARs, CLs. A detailed explanation of the findings have been provided in section 12.4 of this report.

2.6 Information system, data management and control

The PP has provided a description of the provisions and arrangements for monitoring in the PDD v2.0⁷⁷ and the MR v2.0^{8/}. The system assessed by the audit team through documentation and the onsite site inspection is summarized below:

- The selection and management of GHG data and information.
- The processes for collecting, processing, consolidating and reporting data and information on the CCMP.

- The systems and processes that ensure the validity and accuracy of data and information.
- The results of maintenance and calibration of equipment and instruments.

2.7 Audit team

Full names	Role(s) or responsibility(s)	Type(s) of activity(ies) carried out*
Karthik Lakshman	Lead Auditor (onsite)	Completeness check, desk review, remote audit, discussion with project representatives, issuance of findings, report preparation.
Abel Girma Arega	Technical and Host country expert	Desk Review, Interview with PP and Local stakeholders.
Priyanka M S	Technical reviewer	Technical review of the PDD and FVR

3 Validation and verification results

3.1 CCMP components

3.1.1 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

3.1.2 Information from other CCMP institutional participants

Full name(s)	Mrs. K. E. Y. Rani
Name of institution (if applicable)	Kanaka Management Services Private Limited
Roles or responsibilities	CCMP Developer
Identification	U74140KA2007PTC043232
Location	No.271, 1st B Main, SFS 407, 4th Phase, Yelahanka New Town, Bengaluru-560064, India.
Telephone number(s)	Phone: +91-9008167850
E-mail address	info@kms-group.com

3.1.3 CCMP description

The Reppie Waste-to-Energy Project (RWE) in Addis Ababa, Ethiopia, is a well-conceived initiative aimed at addressing the city's escalating municipal solid waste (MSW) management challenges. This project aligns with the city's pressing need for effective waste disposal

solutions while contributing to energy generation and environmental conservation. The validation team confirms the project's compliance with key objectives and its capacity to deliver significant environmental, social, and economic benefits.

The rapid population growth in Addis Ababa, from 4.2 million in 2012 to 5.2 million in 2022, has intensified waste generation, currently estimated at 2,674 tons per day. The aging Koshe landfill, which has been in operation for over 50 years, is inadequate to manage this volume, as evidenced by its collapse in 2017. This incident highlights the urgent need for alternative waste management strategies. The RWEP offers a robust solution by utilizing an advanced incineration process to address the burgeoning waste problem while mitigating associated public health risks and environmental degradation.

The RWEP employs the incineration technology to treat MSW. The facility converts waste into energy by producing steam, which drives turbines to generate electricity for plant operations. This not only reduces dependency on open landfills but also prevents methane (CH₄) emissions, a potent greenhouse gas. The project commenced construction on 14-Sep-2014, and was completed on 19-Aug-2018, with waste intake operations starting on 14-Apr-2019, and incinerator activation on 01-May-2019 and the plant was under pre-operation test run until 31-Dec-2019. The start date for generating greenhouse gas (GHG) emission reductions (ERs) is considered to be 01-Jan-2020, following the completion of the pre-operation test period and commissioning. This interpretation aligns with standard definitions of operational commencement, wherein the project is deemed fully operational only after all necessary testing and commissioning activities have been completed. As per Cercarbono protocol v4.4, the start date is defined as , 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. The 50-year operational lifespan ensures sustained waste management and energy production, contributing to long-term urban sustainability.

Environmental and Social Impacts:

1. Greenhouse Gas Mitigation:

The project avoids methane emissions that would have otherwise been generated through the anaerobic decomposition of organic waste in landfills. Methane's high global warming potential underscores the significance of this mitigation. Furthermore, advanced air pollution control systems effectively manage emissions of nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter (PM), ensuring compliance with environmental standards.

2. Sustainable Waste Management:

By prioritizing waste segregation, recycling, and source reduction, the project addresses potential leakage risks, such as increased waste generation or diversion from recycling. This approach fosters sustainable waste management practices across the community.

3. Environmental Protection:

The treatment of fly ash using chemicals like activated carbon, sodium bicarbonate, and hydrated lime ensures safe disposal, minimizing soil and water contamination risks. Additionally, the reduced reliance on landfills preserves land resources and mitigates the environmental hazards of open dumping.

4. Public Health and Safety:

The project significantly reduces harmful pollutants and pathogens associated with traditional waste disposal, thereby improving public health and safety in Addis Ababa.

5. Employment Creation:

The construction and operation phases of the RWEP have generated substantial employment opportunities for the local community, contributing to economic development and social upliftment.

The validation team confirms that the RWEP meets its stated objectives:

- **Waste Reduction:** The facility drastically reduces the volume of waste requiring land-fill disposal.
- **Energy Recovery:** The conversion of waste to energy provides a sustainable energy source, enhancing self-sufficiency for plant operations.
- **Economic Benefits:** Employment opportunities generated by the project bolster the local economy.
- **Public Health Improvement:** The project's modern waste treatment methods mitigate risks associated with traditional landfills.

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.

3.1.4 Sectoral scope and type of CCMP

The CCMP is categorized under sector 13 waste handling and disposal.

The CCMP is a Type 1 Project (removing more than 10,000 tons of CO₂e per year).

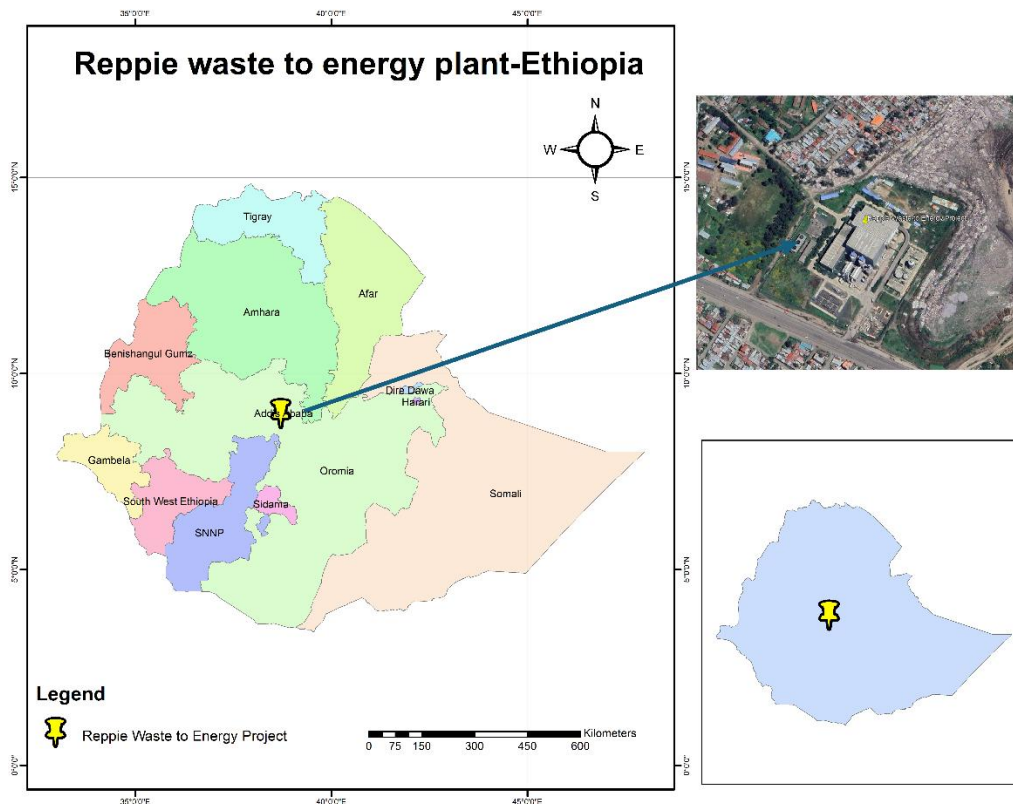
According to Cercarbono's Protocol v4.4^{1/}, the CCMP is considered as Type 1 since it reduces more than 10,000 tons of CO₂e, on average per year (132,978 tCO₂e per year)

3.1.5 Location and limits of the CCMP

The Reppie Waste-to-Energy Plant (RWEPP) project is strategically situated within the Kolfe Keranio sub-city of Addis Ababa, Ethiopia, on the west rim of the country's Great Rift Valley. Its geographic coordinates are **8°58'34"N** and **38°42'35"E**, ensuring an optimal position to address the city's municipal waste management challenges. The facility is approximately 7–8 kilometers from Addis Ababa's city center and operates within the legally defined boundaries of the Koshe landfill site. This boundary extends approximately 1 kilometer northward, 1.5 kilometers southward, 2 kilometers eastward, and 1 kilometer westward from its central operational point, ensuring no overlap with other waste management projects in the region.

This delineation is a critical aspect of the project's design, as it ensures that waste collection operations are effectively centralized and do not interfere with other urban or environmental initiatives. The project's placement within the Koshe landfill site aligns with Addis Ababa City Administration's urban planning strategies and is managed by Ethiopian Electric Power (EEP), ensuring compliance with local and national regulations.

The RWEPP project is a pivotal component of Addis Ababa's waste management and energy strategies, converting municipal waste into energy in a manner that aligns with sustainable urban development goals. The facility's proximity to the city center facilitates efficient waste collection and transportation, thereby reducing logistical challenges and operational inefficiencies. Moreover, the project's integration within the Koshe landfill ensures a systematic approach to managing municipal waste, significantly contributing to environmental sustainability and urban cleanliness.



3.1.6 Total area, facilities, or processes of the CCMP

The project documentation indicates that the total area of the CCMP, the Reppie Waste-to-Energy Plant is 39 hectares. This area comprises the Koshe landfill site and the Reppie waste-to-energy (WtE) facility, with seven hectares dedicated to the incineration facility.

The construction area of the RWEP is reported as 53,120 m², which converts to 5.312 hectares. The area within the red line is 63,901 m², equivalent to 6.39 hectares. These figures align with the overall site layout provided in the Project Design Document (PDD) and reflect the space allocated to the main facility operations, access roads, greenbelt zones, and auxiliary structures.

- **Koshe Landfill Integration:** The Koshe landfill has been utilized as a waste disposal site for over 50 years. Its integration into the CCMP ensures an efficient transition to modern waste-to-energy processes.
- **Reppie Waste-to-Energy Facility:** The WtE facility occupies seven hectares and includes the incineration plant, power generation units, and associated systems for energy recovery and emissions management.
- **Green Belt Area:** The greenbelt, covering 15,936 m² (1.5936 hectares), represents 30% of the facility's total area. This feature ensures ecological balance and reduces the visual and environmental impact of the facility.

- Roads and Site Pavements: A paved area of 10,000 m² (1 hectare) supports transportation and operational logistics.
- Main Building and Auxiliary Structures: The main building area spans 18,784.43 m², and auxiliary structures collectively add up to a total building area of 21,110.09 m².

The total area of the CCMP, including both Koshe landfill and the WtE facility, is reported as 39 hectares in the PDD. Based on the validation, this area is consistent with the project documentation. All primary components of the project, including the landfill site, incineration facility, greenbelt zones, and paved areas, have been accounted for and verified.

If any areas within the CCMP are not directly validated or excluded from the verification, it is because they do not serve critical operational or mitigation functions. For instance, buffer zones or unutilized land that does not directly contribute to the facility's primary objectives are not validated.

3.1.7 Holdership or right of use of the area, facility, or process

The project site, which includes the Combined Complex Management Premises (CCMP) encompassing the Koshe landfill site and the Reppie waste-to-energy facility, is owned by Ethiopian Electric Power Corporation (EEP). Documentation confirming ownership has been presented, including no-lien certificates, which affirm that the property is free from any financial encumbrances or claims. This establishes the clear and uncontested holdership of the property by EEP, ensuring legal authority over the land and facilities for the implementation and operation of the RWEF project.

The relevant permits for the construction and operation of the RWEF have been issued by the Ministry of Water and Energy, Ethiopia. These permits provide the necessary legal framework for the establishment and functioning of the waste-to-energy facility. The permits confirm compliance with Ethiopian regulatory requirements and validate the project's alignment with national energy and environmental policies.

The no-lien certificates and supporting ownership documents are consistent and confirm that EEP holds exclusive rights to the project area.

3.1.8 Characteristics and previous conditions to the start of the CCMP

The Reppie Waste-to-Energy (WtE) facility, owned by the Ethiopian Electric Power (EEP), represents a critical infrastructure development in sustainable waste management and energy production. Construction was completed on 19-Aug-2018, with full operational commencing and generation ERs on 01-Jan-2020, the facility exemplifies a unique partnership model between EEP and the Addis Ababa City Municipal Administration (AACMA). This col-

laboration eliminates direct compensation for waste processing creating a mutually beneficial relationship. EEP gains access to waste as a no cost raw material, while AACMA benefits from significantly reduced landfill waste through incineration. Notably, in 2022, the incineration capacity addressed 70% of the waste transported to the final disposal site underscoring its importance in waste management.

The waste management workflow at the Reppie facility is robust and well structured. Waste is delivered to the plant by municipal and private garbage trucks, which transported approximately 2,674 tons daily in 2022. Upon arrival, the waste is weighed, unloaded into a bunker, on managed to prevent leachate leakage. Leachate is collected securely, treated in a dedicated facility, and discharged into a nearby inland river after meeting local effluent standards.

The incineration process is designed to maximize energy recovery while minimizing environmental impacts. Waste is transferred into the feed hopper via a grab crane, and combustion in the furnace converts chemical energy into thermal energy. Gases such as CO₂, NO_x, SO₂, HF, HCl, and particulates are emitted during combustion but are effectively managed using advanced pollution control technologies. These include activated carbon, sodium bicarbonate, hydrated lime and bag filters, which collectively reduce the release of harmful substances like dioxins and heavy metals. The flue gas treatment (FGT) system ensures that exhaust gases are de-acidified, de-dusted, and treated for toxic substances before atmospheric release.

The Reppie WtE facility generates electricity through a highly efficient thermal-to-electricity conversion process. Heat from combustion generates superheated steam in the boiler, which powers a steam turbine connected to a generator. This setup produces sufficient electricity for the plant's operational needs, with excess power fed into the national grid, contributing to Ethiopia's energy supply. Condensed steam is recycled back to the boiler, ensuring a closed-loop system that optimizes resource utilization.

Post-combustion residues, including slag and fly ash, are meticulously managed. Slag from the grate and boiler ash are conveyed to a slag removal system and either buried at a landfill or partially reused as construction materials or road base. Fly ash, collected by the FGT system, is dumped in landfills, although feasibility studies suggest its potential use in manufacturing construction blocks. The facility generates approximately 85 tons of incineration ash daily, with some of it repurposed, aligning with sustainable waste disposal practices.

The Reppie WtE facility plays a significant role in addressing Addis Ababa's waste management challenges. The city generates 2,674 tons of waste daily, 85% of which is collected and transported to the final disposal complex. At Reppie, 394 tons per day are incinerated, reducing landfill dependency. Additionally, approximately 228 tons of waste are recycled

daily, showcasing the city's strides toward integrating recycling with waste-to-energy practices.

The Reppie WtE facility is a model of sustainable urban waste management and renewable energy generation. By reducing landfill dependency, recovering energy, and exploring reuse opportunities for incineration byproducts, it contributes to environmental sustainability and energy security. However, further steps, such as scaling up recycling efforts and increasing efforts and increasing the reuse of fly ash in construction materials, could enhance the facility's environmental and economic benefits. Continuous monitoring of emissions and waste processing efficiency is essential to ensure compliance with environmental standards and to optimize operations.

3.1.9 Technologies, products, and services of the CCMP

The Reppie WtE facility is a flagship project owned by Ethiopian Electric Power (EEP) and developed in collaboration with the Addis Ababa City Administration (AACA). With an investment of USD 95.88 million and ETB 434.53 million, the facility spans an area of 53,120 m². Its design and operations highlight the integration of advanced waste-to-energy technology with sustainable urban waste management practices.

Technical and Operational Design:

1.1 Incinerators:

- The facility is equipped with two air-cooled step grate incinerators designed to handle municipal solid waste (MSW). Key technical parameters include:
- Treatment Capacity: Each incinerator processes 640 tonnes per day, with a total daily capacity of 1,280 tonnes.
- Heat Value Range: The designed MSW heat value is 7,000 kJ/kg, with an operational range of 7,000–9,500 kJ/kg.
- Manufacturer: Sanfeng Covanta Environment Industry Co., Ltd.
- Annual Operation: Each incinerator operates 7,400 hours per year, ensuring continuous waste processing.

1.2 Waste Heat Boilers:

- Two waste heat boilers recover thermal energy from combustion:
- Steam Outlet Pressure: 6.0 MPa.
- Steam Outlet Temperature: 420°C.
- Thermal Efficiency: 80.94%.
- Manufacturer: Hangzhou Boiler Group.

- Flue Gas Flow Rate: 129,500 Nm³/h, with an exhaust gas temperature of 195°C.

1.3 Condensing Steam Turbines:

- The facility utilizes two condensing steam turbines:
- Rated Power: Each turbine generates 25 MW of electricity, totaling 50 MW.
- Steam Inlet Parameters: 5.8 MPa pressure and 415°C temperature.
- Manufacturer: Hangzhou Steam Turbine Co., Ltd.

1.4 Generators:

- The power generation system includes two generators:
- Rated Power: 25 MW each.
- Voltage: 10,500 V.
- Frequency: 50 Hz.
- Rotational Speed: 3,000 RPM.

2. Waste Management and Processing:

2.1 Daily and Annual Capacity

The facility processes 1,280 tonnes of MSW daily, equating to an annual capacity of 420,000 tonnes based on 300 operational days (7,200 hours). This capacity represents a significant reduction in landfill dependency and ensures efficient waste-to-energy conversion.

2.2 Waste Handling and Feeding

- Bunker Capacity: The waste bunker has a capacity of 22,658 m³.
- Waste Grab Cranes: Two 8 m³ cranes, each with a capacity of 12.5 tonnes, manage waste feeding with a grabbing efficiency of 90%.
- Feeding System Dimensions: 6.2 m x 12.4 m x 3.1 m with a capacity of 120 m³.

2.3 Leachate Management

Leachate Transfer Pumps: Two self-suction centrifugal pumps handle leachate with a flow rate of 20 m³/h at a height of 30 m, ensuring secure collection and treatment.

3. Energy Output and Efficiency:

The facility produces 185 GWh of electricity annually, with thermal energy capacity per incineration line ranging from 36.3 MWth to 55 MWth. The advanced energy recovery systems ensure:

- Boiler Efficiency: 80.94%.

- **Self-Sustainability:** The plant utilizes generated power for operations, feeding surplus electricity into the national grid.

4. Auxiliary Facilities and Infrastructure:

4.1 Tipping Hall and Platforms

- **Tipping Hall Dimensions:** 75.6 m x 24 m x 7 m.
- **Platforms:** Six waste tipping gates accommodate >4-ton trucks, including a fleet of 16-ton IVECO compactor trucks.

4.2 Weight Bridges

Number of Units: Two bridges with a 50-tonne capacity and 20 kg precision ensure accurate waste measurement.

5. Environmental Safeguards:

The facility incorporates advanced measures to minimize environmental impact:

- **Emission Control:** The facility employs bag filters, activated carbon, and sodium bi-carbonate to reduce pollutants like dioxins and heavy metals.
- **Leachate Treatment:** Treated leachate meets local effluent standards before discharge.
- **Ash Management:** Incineration ash is either buried in landfills or partially utilized for construction materials.

3.1.10 Assessment of the chronological plan

The VVB reviewed the key dates, timelines, and monitoring framework of the CCMP (Carbon Credit Mitigation Project) to ensure alignment with the Cercarbono Protocol for Voluntary Carbon Certification (Version 4.4)^{/1/} and relevant carbon accounting principles. The expected operational lifetime of the CCMP is 50 years given by the technical specifications^{/16/} of the facilities in the Project. The start date of the CCMP is the start date of the operation of the plant: that is 01-Jan-2020, which is verified from the plant records^{/11/}.

The accreditation period of the CCMP is 10 years, as determined for projects other than the land use sector by the Cercarbono's Protocol^{/1/} for Voluntary Carbon Certification (ver. 4.4). The crediting period is set from 01-Jan-2020, to 31-Dec-2029, both dates inclusive, and is also renewable twice.

Regarding monitoring and verification, the project has adopted a monthly monitoring frequency, ensuring consistent data collection and tracking of emission reductions. Monitoring

reports may be requested at least monthly or at most biannually, offering flexibility while maintaining robust oversight. Periodic verifications are scheduled to occur annually, ensuring compliance with certification requirements. The current monitoring period is from 01-Jan-2020 to 31-Dec-2024 (5 years), with subsequent verifications planned at a biennial frequency starting from 01-Jan-2025.

The stakeholder meeting for the project took place on 10-Jan-2014, followed by the plant commissioning on 01-May-2019. The project's formal registration under Cercarbono is scheduled for 16-Jan-2025, marking a critical milestone in its certification journey. The validation process is currently ongoing, ensuring that the project meets all necessary requirements for accreditation. The first verification covers the period from 01-Jan-2020 to 31-Dec-2024, aligning with the initial monitoring phase. Future verifications are planned from 01-Jan-2025 onwards, with proponents indicating an intention to conduct these every two years post-2024.

In conclusion, the project's timeline, monitoring framework, and verification approach demonstrate a structured and well-planned.

3.2 Methodological elements

3.2.1 Selected methodology

The methodology applied for the project activity is ACM0022 Large-scale Consolidated Methodology: Alternative waste treatment process version 3.0.^{/4/}

The tools applied are as follows;

This methodology also refers to the latest approved versions of the following tools and guidelines:

- (a) TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion version 3.0^{/6/}
- (b) TOOL04 : Emissions from solid waste disposal site, version 8.1^{/6/}
- (c) TOOL06: Project emissions from flaring, version 4.0^{/6/}
- (d) TOOL14: Project and leakage emissions from anaerobic digesters, version 3.0^{/6/}
- (e) TOOL23: Additionality of first-of-its-kind project activities^{/6/}

Applicable conditions of the

Validator Opinion

Methodology ACM0022	
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 Reppie WtE facility incinerates municipal solid waste (MSW) to produce electricity. Located 7–8 km from Addis Ababa's city center, it treats fresh waste and sends surplus energy to the national grid. The CCMP meets the requirements by implementing a compliant waste treatment process.
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 processes only fresh MSW via incineration, with no claims for emissions reduction from alternative processes like composting or anaerobic digestion. The treatment of fresh waste aligns with the methodology.
(j) Neither the fresh waste nor the products from the project plant are stored on-site under anaerobic conditions;	Waste is stored in a ventilated waste bunker for 4–5 days before incineration. Combustion air is drawn from the waste bunker, ensuring an aerobic environment. By-products are immediately disposed of without anaerobic storage. The aerobic storage and handling meet the requirements.
(k) Any wastewater discharge resulting from the project activity is treated in accordance with applicable regulations;	All wastewater is treated and reused within the facility, eliminating discharge. The internal reuse of wastewater adheres to regulatory and methodological standards.
(l) The project activity does not reduce the amount of waste that would be recycled in the absence of the project activity.	In the baseline scenario, waste was disposed of at the Koshe landfill with no recycling. The project's incineration process does not reduce recycling rates.

	There is no impact on recycling.
(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 are no legal mandates requiring incineration. Waste was previously landfilled without regulatory requirements for treatment. No regulatory compliance issues were identified.
(n) Hazardous wastes/wastewater are not eligible under this methodology.	The project treats only MSW and does not involve hazardous waste or wastewater. The project adheres to this requirement.
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 waste was disposed of at the Koshe landfill, which lacked an LFG capture system. The baseline scenario aligns with M3 as defined in ACM0022.
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. Applicable waste by-products: Incineration by-product (e.g. inert materials); Wastewater discharge; Non- biodegradable materials that may	The project incinerates fresh MSW to generate electricity. By-products include slag, fly ash, and flue gases, with no auxiliary fossil fuel use exceeding 50% of total energy. The incineration process adheres to all applicable conditions.

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.

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.

The project emissions from fossil fuel combustion have been calculated in the project emission section of the document, aligning with the applicability conditions of this tool. The methodology follows the prescribed approach by considering the quantity of fuel combusted and its properties. The tool is correctly applied.

The application of this tool is appropriate and in compliance with the methodology.

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

The project falls under Application B, as it avoids waste disposal at a solid waste disposal site (SWDS). In accordance with Point 3(b), the tool is applicable for both ex ante and ex post estimation of emissions. Furthermore, since different types of residual waste are prevented from disposal, the tool has been applied separately for each type

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); (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.	of waste and municipal solid waste (MSW), aligning with Point 5. The application of this tool is appropriate and correctly justified.
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 (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.	The project involves flaring of biogenic gas, where methane is the dominant component (Point 3(a)). The residual gas is flared without auxiliary fuels, and an open flare is used. As per the tool, a default flare efficiency of 50% has been applied. Point 4 (concerning auxiliary fuels) is not applicable since no additional fuels are used. The tool is correctly applied, and all conditions have been met.
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	The anaerobic digester in the project stores wastewater and leachate, leading to methane generation, which is then flared. The following conditions of the tool are applicable: 3(d): CH₄ emissions from flaring of biogas.

leaks through the roof and side walls, and re-lease 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. 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.	4(b): CH₄ emissions from anaerobic decay of digestate in an SWDS or anaerobic storage. N₂O emissions from physical leakages are not applicable, as these are considered minor emission sources. The tool is applied correctly, and the conditions match the project scenario.
TOOL23: Additionality of first-of-its-kind project activities	The project qualifies as First of Its Kind based on the following factors: 1. Technological Innovation: The waste-to-energy (WtE) incineration technology is novel in Ethiopia, with no other similar plants operational in 2019. 2. GHG Emission Reduction: The project reduces methane emissions from open dumping and generates thermal energy and electricity, which is a unique practice in the region.

	3. Barriers to Adoption: High upfront costs, financing difficulties, and low investor confidence in WtE technology in Ethiopia justify the additionality claim. The project meets the criteria for first-of-its-kind additionality, and the tool is appropriately applied.
Specific applicability conditions for the different waste treatment processes	Validator Opinion
1. Composting or Co-Composting	The methodology specifies that composting applies to waste types included in the tool "Project and leakage emissions from composting." The proposed project is an incineration process and does not involve any composting. Validation Opinion: Not Applicable. The composting process is irrelevant to the project activity, which focuses solely on incineration.
2. Anaerobic Digestion	Anaerobic digestion involves the production of biogas from wastewater or fresh waste, excluding hospital and industrial waste. The proposed project is an incineration process and does not involve anaerobic digestion of waste or wastewater. Validation Opinion:

	Not Applicable. Anaerobic digestion is not part of the project's waste treatment strategy.
3. Thermal Treatment	Thermal treatment typically applies to RDF/SB (Refuse-Derived Fuel/Secondary Biomass) production from fresh waste. The project activity does not involve the production of RDF/SB and is strictly an incineration process. Validation Opinion: Not Applicable. Thermal treatment as defined in the methodology is not employed in the project.
4. Mechanical Treatment	Mechanical treatment processes produce RDF/SB and recover recyclable materials like glass, aluminium, and metals. The project does not include mechanical sorting or processing, it directly incinerates the waste. Validation Opinion: Not Applicable. The project does not utilize mechanical treatment techniques.
5. Gasification	Gasification involves converting fresh waste into syngas for generating heat or electricity, with by-products like inert materials and runoff wastewater. The project is an incineration facility and does not include gasification. Validation Opinion:

	Not Applicable. Gasification processes are not used in the project activity.
6. Incineration	The project is an incineration facility treating fresh MSW to generate electricity. The technology employed is compliant with the specific applicability conditions: • Incineration technology (e.g., rotary kiln, grate type) is applicable. • The fraction of energy generated by auxiliary fossil fuels is less than 50% of the total energy generated. • By-products include inert materials, runoff wastewater, and recyclable metals. Validation Opinion: The incineration process fully meets the methodological requirements and is applicable to the project activity.

3.2.2 Additionality

The additionality of the project has been assessed using CDM Tool 23: Additionality of First-of-its-Kind Project Activities, Version 3.0^{6/}, and the "Tool to Demonstrate Additionality of Climate Change Mitigation Initiatives, Version 2.0.1." The following is a detailed validation opinion on the additionality of the project as per the requirements of CDM Tool 23^{6/}.

Assessment of First-of-Its-Kind Status:

Technological Innovation

The project uses incineration technology, which is novel in Ethiopia. As of May 2019, there were no other waste-to-energy (WtE) plants utilizing similar technology and fuel operational in Ethiopia. The baseline practice in Ethiopia is open dumping of municipal solid waste (MSW), which leads to methane emissions. The project demonstrates technological innovation by avoiding methane emissions through the incineration of MSW and generating thermal energy for electricity production.

Validation Opinion: The project qualifies as first-of-its-kind since no similar WtE plants were operational in Ethiopia at the time of commissioning, fulfilling the criterion of technological uniqueness.

Measures to Reduce GHG Emissions and Provide Outputs

The project prevents methane emissions by using MSW as fuel, thereby avoiding open dumping of waste. It produces electricity from thermal energy generated by the incineration process. No other plants in Ethiopia as of May 2019 provided a similar combination of GHG mitigation measures and outputs.

Validation Opinion: The measures and outputs are unique in Ethiopia, further substantiating the project's first-of-its-kind status.

Barriers to Adoption

Ethiopia, as a Least Developed Country (LDC), faced significant barriers in adopting WtE technologies:

- High upfront costs and financing challenges.
- Lack of investor confidence in novel technologies.
- Operational and technological risks associated with incineration.

These barriers support the argument that such a project faced significant adoption hurdles, emphasizing its additionality.

Validation Opinion: The identified barriers effectively demonstrate that the project faced challenges unique to first-of-its-kind initiatives.

Assessment Based on CDM Tool 23 Requirements

Step 5.1 - First-of-Its-Kind Assessment Criteria

1. Define Prevailing Practice(s) and CCMP Technology:

Prevailing Practice: Open dumping of MSW is the dominant waste disposal method in Ethiopia.

CCMP Technology: Incineration of MSW for thermal energy generation is the technology used in the project.

There are no similar WtE plants operational in Ethiopia as of May 2019.

Validation Opinion: The prevailing practice and CCMP technology are clearly defined, and the project is demonstrated to be technologically unique.

2. Define Applicable Geographical Area:

The geographical area is defined as the country of Ethiopia, considering its LDC status and the challenges in adopting new technologies. As of May 2019, Ethiopia had no operational WtE plants, further justifying the project's first-of-its-kind status in the defined area.

Validation Opinion: The geographical area is appropriately defined, aligning with the project's unique context and challenges in Ethiopia.

3. Consideration of Implementation Start Date:

The project was commissioned in 2019, and the analysis confirms that no other similar CCMPs were validated, implemented, or operational in Ethiopia at that time. The measures and outputs, including methane emission reduction and electricity generation, were unique in Ethiopia.

Validation Opinion: The analysis of implementation timing and project uniqueness confirms compliance with CDM Tool 23.

The project meets all the requirements of CDM Tool 23 for first-of-its-kind project activities. It is technologically unique, demonstrates significant barriers to adoption, and provides outputs and measures that are novel in Ethiopia. The definition of prevailing practices, geographical scope, and implementation timing is robust and aligns with the methodology.

The project qualifies for additionality under the first-of-its-kind approach as per CDM Tool 23 and effectively justifies its eligibility for carbon crediting based on its innovative approach to waste management and emission reductions in Ethiopia.

3.2.3 No double counting

The validation team checked the Verra website (<https://registry.terra.org/app/search/VCS>), GS website (<https://registry.goldstandard.org/projects?q=&page=1>), and GCC website (https://projects.globalcarboncouncil.com/pages/submitted_projects) with the help of the CCMP title, capacity of the CCMP, CCMP location etc., and confirms that this CCMP is not registered or in process of registration under Verra, or GS or other projects of GCC. The validation team also determined that the CCMP is not currently registered with any ETS (domestic and worldwide for I-REC) (<https://fotonplatform.com/santraller/>).

An official document declaring that the project has not been or will not be registered under any other climate change mitigation standards or certification schemes has been signed by the owner of the CCMP. The concerned document has been made available to the validation team.

3.2.4 Baseline scenario

The baseline scenario involves the disposal of municipal solid waste (MSW) in open landfills, specifically the Koshe landfill site in Ethiopia. Open dumping is the prevailing waste management practice in the region and contributes significantly to greenhouse gas (GHG) emissions, particularly methane (CH₄) emissions generated through the anaerobic decomposition of organic waste. Methane, being a potent greenhouse gas, has a global warming potential much higher than carbon dioxide (CO₂), making the emissions from this baseline scenario a critical environmental concern.

In the absence of the Climate Change Mitigation Project (CCMP), the continuation of open dumping at Koshe landfill would remain the most likely scenario. The emissions would persist due to the lack of alternative waste treatment technologies in Ethiopia, further exacerbating the region's environmental and public health challenges.

The project represents a shift in waste management practices by implementing a waste-to-energy (WtE) solution, where MSW is incinerated to produce thermal energy, which is subsequently converted into electricity. This innovative approach effectively mitigates methane emissions from the landfill by diverting waste and utilizing it as a resource. Additionally, the project contributes to the reduction of CO₂ emissions by reducing reliance on open dumping and replacing conventional electricity generation from fossil fuels with renewable energy.

The validation team confirms that the project has complied with all applicable regulatory policies and requirements of the host country, Ethiopia. These include environmental, social, and waste management regulations, as well as the necessary permits for the construction and operation of the WtE facility.

There are no barriers or conditions identified that would prevent the project from continuing during its implementation phase. This indicates that the project has been designed and implemented in alignment with Ethiopia's regulatory framework and sustainable development goals.

The compliance with regulatory requirements not only ensures the feasibility and legality of the project but also demonstrates the project proponent's commitment to adhering to national environmental standards. Moreover, the project aligns with Ethiopia's broader climate and energy policies by addressing the dual objectives of reducing GHG emissions and generating renewable energy.

The validation team acknowledges the robustness of the baseline scenario analysis and confirms that the project represents a significant improvement over the existing waste management practices in Ethiopia. The shift from open dumping to a waste-to-energy model addresses critical environmental challenges and introduces a sustainable and innovative waste treatment solution.

Additionally, the project's compliance with regulatory policies ensures that it is implemented responsibly and in a manner that aligns with national and international environmental objectives. The absence of barriers or conditions preventing project implementation further reinforces its viability and credibility.

The project's focus on mitigating methane emissions from landfills, along with its contribution to renewable energy generation, underscores its importance as a climate change mitigation initiative. It also demonstrates its additionality by addressing baseline emissions that would otherwise persist under the prevailing waste management practices in Ethiopia.

The project's regulatory compliance, innovative approach, and contribution to GHG emission reductions establish its relevance and significance as a climate change mitigation initiative. The validation team confirms that the project aligns with all applicable requirements and supports its implementation as a sustainable solution for waste management and renewable energy generation in Ethiopia.

3.2.5 Project scenario

The Waste-to-Energy (WtE) project aims to address the significant environmental and energy challenges posed by municipal solid waste (MSW) management. The project employs

modern incineration technology, equipped with advanced emissions control systems, to convert MSW into energy in the form of electricity and heat. These incineration systems, with an operational lifespan of approximately 50 years, represent a durable and efficient solution for sustainable waste management.

The advanced emissions control systems integrated into the incinerators ensure that pollutants generated during the combustion process are captured and managed effectively. This minimizes environmental impacts while enabling the project to comply with stringent air quality standards. The project's high energy conversion efficiency ensures that large volumes of waste are processed, maximizing the output of renewable energy and reducing reliance on fossil fuels.

In the baseline scenario, municipal solid waste would be disposed of in open landfills, a practice that generates significant quantities of methane (CH₄), a greenhouse gas with a global warming potential 28-34 times greater than carbon dioxide (CO₂) over a 100-year period. Landfilling is inherently inefficient and environmentally detrimental, as it does not recover energy and exacerbates GHG emissions.

The project modifies this baseline scenario by introducing incineration as a sustainable alternative. By diverting waste from landfills, the project eliminates the methane emissions that would have otherwise been generated through anaerobic decomposition. Furthermore, the project quantifies GHG reductions by comparing the emissions from the controlled incineration process with the emissions that would have occurred under the baseline landfilling scenario. This comparative analysis is conducted using standardized measurement protocols to ensure accuracy, transparency, and reliability in emission reduction calculations.

The project represents a significant enhancement of Ethiopia's existing waste management infrastructure. The integration of incineration facilities into the current system addresses the inefficiencies associated with traditional landfills and recycling centers. While existing facilities provide limited energy recovery and marginal contributions to GHG emissions reduction, the WtE project offers a transformative approach by treating waste as a resource.

The project also ensures compatibility with existing waste collection and transportation systems, improving overall operational efficiency. By incorporating modern technology and adhering to best practices, the project positions itself as a benchmark for sustainable waste management in Ethiopia and other developing regions.

The validation team has thoroughly assessed the project's technological features, baseline scenario, and its integration into the existing waste management framework. The use of advanced incineration technology with emissions control systems demonstrates a clear

technological advantage over baseline practices. The project's ability to generate substantial energy outputs while mitigating GHG emissions is consistent with its objectives as a climate change mitigation initiative.

The quantification of GHG reductions through a robust and standardized methodology ensures the credibility and transparency of the project's claims. Furthermore, the project's alignment with Ethiopia's sustainability goals and its potential to serve as a model for other regions underscore its significance.

The WtE project is a transformative initiative that effectively addresses the environmental and energy challenges posed by municipal solid waste management in Ethiopia. By replacing landfilling with advanced incineration technology, the project achieves significant GHG emissions reductions while producing renewable energy. Its integration into the existing waste management system enhances operational efficiency and provides a sustainable waste treatment solution. The validation team confirms the project's technological viability, its alignment with baseline emission reduction goals, and its overall contribution to sustainable development.

3.2.6 GHG emission sources

All the GHG emissions agree with the methodology used. The monitoring plan is appropriate for monitoring the GHG emissions. There are no identified risks that substantially affect the GHG emissions.

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 flaring	NO	NO	NO	NO	YES	NO	NO	NO	NO
Emissions from the waste treatment processes	NO	NO	NO	YES	YES	YES	NO	NO	NO

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 from wastewater treatment.	NO	NO	NO	YES	NO	NO	NO	NO	NO
Leakage Emissions from the anaerobic digester	NO	NO	NO	NO	NO	NO	YES	NO	NO

The validation team has reviewed the emission sources and confirms the following:

- The baseline scenario includes significant methane emissions from SWDS, which are entirely eliminated in the project scenario due to waste diversion.
- On-site fossil fuel consumption emissions, relevant in the baseline, are negligible or eliminated in the project scenario through efficient operations.
- The incineration process in the project scenario introduces controlled emissions of CO₂, CH₄, and N₂O, which are quantified and mitigated using advanced technologies.
- No emissions are observed from wastewater treatment in either the baseline or project scenario due to effective management systems.
- The project demonstrates no significant leakage emissions, further strengthening its environmental sustainability.

The WtE project achieves significant environmental benefits by replacing the baseline practice of open landfilling with advanced waste treatment through incineration. The project effectively eliminates methane emissions from SWDS and ensures controlled management of emissions from the waste treatment process. The validation team concludes that the project's emission sources, mitigation measures, and leakage assessments align with the applicable methodologies, confirming its role as a sustainable climate change mitigation initiative. The monitoring plan is appropriate for monitoring GHG sources and emissions.

3.2.7 Deviations in the implementation of the CCMP from the Project Description Document

There is no deviation in the implementation of the CCMP from the PDD.

3.2.8 Methodological deviations

The PDD v2.0^{7/} has been checked in line with the requirements of the ACM0022 version 3.0^{4/} and relevant tools by the validation team, which is found correct.

3.2.9 Crediting period

The crediting period chosen by the CCMP holder is 10 years which is renewable twice. The start date of the crediting period is 01-Jan-2020, which is the date on which the plant facility started generating ERs. The VVB reviewed the plant records and commissioning certificate issued by EEP(Ethiopian Electric power) and confirmed the date of commissioning of the incineration facility.

The length of 1st crediting period = 01-Jan-2020 to 31-Dec-2029.

The VVB confirmed that the crediting period chosen by the CCMP holder is appropriate and is in compliance with Cercarbono's Protocol for Voluntary Carbon Certification versión 4.4.

3.2.10 Quantification of GHG emissions in the baseline scenario

Ex-Ante Baseline emissions:

As per the applied methodology ACM0022 v3.0^{4/}, baseline emissions are calculated as per the following:

Baseline Emissions:

Formula:

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

where:

BE_y : Baseline emissions in year (tCO₂e).

$BE_{CH_4,t,y}$: Methane emissions from SWDS in year (tCO₂e).

$BE_{WW,t,y}$: Methane emissions from organic wastewater treatment in year (tCO₂e). Not applicable for this project.

$BE_{EN,t,y}$: Emissions from electricity consumption by the grid. Not applicable for this project.

$BE_{NG,t,y}$: Emissions from natural gas use. Not applicable for this project.

$RATE_{compliance,t}$: Compliance rate for waste treatment in year . For this project, assumed to be 0.

Methane Emissions from SWDS:

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

Where:

$BE_{CH_4,t,y}$: 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)

Parameters used in the equation:

1. φ_y : Model correction factor
 - Represents uncertainties in the model
 - Default value : 0.85 as per Tool04
2. f_y : Fraction of methane captured

Values:

- 0.2 if the regulation specifies installing a flare system without requiring specific capture rates.
- 0 if there's no requirement for methane capture.

For this Project: $f_y = 0$.

3. GWP_{CH_4} : Global Warming Potential of methane

- Represents the warming effect of methane relative to CO₂.
- Default value = 27.

4. OX : Oxidation factor

- Accounts for the oxidation of methane before it escapes to the atmosphere.
- Default value = 0.1

5. F : Fraction of methane in landfill gas

- Proportion of methane in landfill gas (volume basis)
- Default value = 0.5

6. $DOC_{f,y}$: Fraction of degradable organic carbon decomposed

- Represents the fraction of organic carbon in the waste decomposed into methane.
- Default value = 0.5.

7. MCF_y : Methane correction factor

- Reflects the conditions of the landfill affecting methane generation
- Default values:
 - $MCF_y = 1$ for anaerobic managed landfills.
 - $MCF_y = 0.8$ for unmanaged shallow landfills.
 - Chosen value = 1.

8. $W_{j,x}$: Amount of waste type j disposed in year x

- Represents the amount of organic waste deposited in the landfill.
- $W_{j,x}$: $W_x \times p_{j,x}$, where :
 - W_x = Total waste disposed of in year x .
 - $p_{j,x}$ = Fraction of waste type j .

9. DOC_j : Degradable organic carbon fraction for waste type j

- Proportion of carbon in the waste that is decomposable.
- Default values for waste types:
 - Paper = 0.4
 - Food = 0.15
 - Wood = 0.43
 - Textiles = 0.24

10. k_j : Decay rate for waste type j

- Reflects how fast waste decomposes based on its type and climate.
- Default value for decay rate:
 - Wet tropical conditions = 0.3

➤ Dry conditions = 0.06.

Emissions not applicable to the Project:

- $BE_{WW,t,y}$: Wastewater Emissions
- $BE_{EN,t,y}$: Energy-Related Emissions
- $BE_{NG,t,y}$: Natural Gas Emissions

Baseline Calculation Summary:

For the project activity, baseline emissions only consider methane emissions from SWDS ($BE_{CH4,t,y}$).

$$BE_y = BE_{CH4,t,y} \times (1 - RATE_{compliance,t})$$

Substituting values:

- $BE_{CH4,t,y} = 2,066,235$
- $RATE_{compliance,t} = 0$.

$$BE_y = \mathbf{206,624} \text{ tCO}_2\text{e per year}$$

Ex-Post Baseline emissions:

The ex post Baseline emissions are calculated in accordance with the applied methodology. The monitored values are as follows:

Monitoring period	Baseline scenario GHG emissions (tCO ₂ e)
01/01/2020 to 31/12/2020	89,882
01/01/2021 to 31/12/2021	75,047
01/01/2022 to 31/12/2022	61,779
01/01/2023 to 31/12/2023	1,08,099
01/01/2024 to 31/12/2024	1,32,115
Total	4,66,922

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

Ex-Ante Project Emissions:

As per the applied methodology ACM0022 v3.0^{4/}, project emissions are calculated as per the following:

Project Emissions:

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

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.

Below is a detailed review of each parameter involved in the emissions calculations for this particular project.

Parameters involved:

1. Project Emissions from Composting or Co-composting ($PE_{COMP,y}$):

- This parameter represents emissions from composting or co-composting activities, but since the project does not involve composting or co-composting, this term is zero.
- The project does not involve the composting of organic waste, so the emissions from this process are zero.

2. Project Emissions from Anaerobic Digestion ($PE_{AD,y}$):

Anaerobic digestion involves the breakdown of organic matter in the absence of oxygen, producing biogas, which can be used for energy. The emissions from this process are a sum of several components:

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

- $PE_{EC,y}$ (Electricity Consumption Emissions): If the anaerobic digester consumes electricity, project emissions arise from the electricity use, unless it's sourced from renewable energy. In this case, the project does not involve electricity consumption from non-renewable sources, so $PE_{EC,y} = 0$.
- $PE_{FC,y}$ (Fossil Fuel Consumption Emissions): If fossil fuels are used in the anaerobic digestion process, emissions are calculated based on the fuel type and quantity. However, for this project, $PE_{FC,y} = 0$.
- $PE_{CH_4,y}$ (Methane Emissions from Digester): Methane leaks from the digester and is a major source of emissions in anaerobic digestion. The amount of methane produced is calculated based on the biogas flow and methane fraction.

- Formula used: $PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4}$
- Here, the $Q_{CH_4,y}$ is the quantity of methane produced, and the $EF_{CH_4,default}$ is a default emission factor for methane, while GWP_{CH_4} is the global warming potential of methane.

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

$$\begin{aligned} Q_{CH_4,y} &= 2,863,060 \times 0.6 \times 0.000067 \\ &= 1150.95 \text{ tCH}_4 \end{aligned}$$

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

- $PE_{CH_4,y} = 1150.95 \times 0.028 \times 27$
= 870.12 tCO₂

- $PE_{flare,y}$ (Flaring Emissions): If the biogas is flared (burned off) to reduce its impact, emissions are generated. These emissions are calculated by the flaring efficiency and biogas quantity.

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

Where:

$PE_{\text{flare},t,y}$ = 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)

$$PE_{\text{flare},t,y} = 57092.55 * 0.0168 * 0.25 * 0.8 * 0.5 * 27$$

$$PE_{\text{flare},t,y} = 2587.48 \text{ tCO}_2\text{e}$$

In this project, $PE_{AD,y} = 870.12 + 2587.48 = 3457.59 \text{ tCO}_2\text{e}$.

3. Project Emissions from Gasification ($PE_{GAS,y}$):

Gasification is a process where organic material is converted into syngas for energy production. However, this project does not involve gasification, so the emissions from this process are zero.

4. Project Emissions Associated with RDF/SB ($PE_{RDF_SB,y}$):

RDF/SB (Refuse Derived Fuel/Solid Biofuels) is a type of waste treatment process that is not used in this project. Therefore, emissions related to RDF/SB production are zero.

5. Project Emissions from Incineration ($PE_{INC,y}$):

Incineration involves burning waste materials to reduce their volume and can produce significant emissions. The emissions from incineration are the sum of several components:

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

Where:

- $PE_{COM,INC,y}$ (Emissions from Combustion within the Project Boundary): This is calculated based on the type of waste burned and its fossil content. The emissions from combustion are split into CO₂, methane (CH₄), and nitrous oxide (N₂O).
- $PE_{EC,INC,y}$ (Emissions from Electricity Use for Incineration): If electricity is used in the incineration process, emissions would arise from fossil-fuel-generated electricity. If renewable sources are used, this is zero.
- $PE_{FC,INC,y}$ (Emissions from Fossil Fuel Consumption for Incineration): If fossil fuels are used in the incineration process, this term accounts for the associated emissions.
- $PE_{ww,INC,y}$ (Emissions from Wastewater Treatment in Incineration): If wastewater is generated during incineration, this term calculates emissions associated with its treatment.

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

$$PE_{INC,y} = 51,114 + 0 + 1115.2 + 0$$

$$PE_{INC,y} = 52,229 \text{ tCO}_2\text{e}$$

Calculation for Project Emissions from Combustion within the Project Boundary ($PE_{COM,c,y}$):

General Calculation for Combustion Emissions ($PE_{COM,c,y}$)

The emissions from combustion processes, including gasifiers, incinerators, RDF/SB combustors, and syngas burners, are calculated by considering three major greenhouse gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). The emissions are calculated

based on the amount of waste fed into the combustor and the characteristics of the combustion process. Notably, flares and biogas combustors are excluded from this calculation, as they are handled separately.

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

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

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

$$PE_{COM,C,y} = 44,174 + 6940$$

$$PE_{COM,C,y} = 51,114 \text{ tCO}_2$$

Calculation for Project emissions of CO₂ from combustion within the project boundary ($PE_{COM_CO_2,c,y}$):

CO₂ emissions from combustion are calculated by considering the fossil carbon content of the fresh waste, RDF/SB combusted, or the stack gas. The methodology offers three options for calculating CO₂ emissions:

- Option 1: Sorting the fresh waste into components of waste type j and determining the fossil-based carbon content for each waste type.
- Option 2: Calculating based on the fossil-based carbon content of the unsorted waste or RDF/SB. This option is applicable if RDF/SB is used and sorting into waste fractions is not required.
- Option 3: Measuring directly the fossil-based carbon content of the stack gas.

In this scenario, Option 1 is applied, where waste is sorted into different components, and the fossil carbon content of each waste type is determined.

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

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 participant 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

$$PE_{COM,CO_2,c,y} = 44,174 \text{ tCO}_2$$

Calculation for Project emissions of CH₄ and N₂O from combustion within the project boundary ($PE_{COM_CH_4,N_2O,c,y}$):

Emissions of methane (CH₄) and nitrous oxide (N₂O) are generally considered negligible from RDF/SB combustion, so they are usually neglected. However, in cases of gasification or incineration, two options are available for estimating these emissions:

- Option 1: Monitoring the N₂O and CH₄ content in the stack gas.
- Option 2: Using default emission factors to calculate emissions based on the amount of fresh waste combusted.

For this project, Option 2 is adopted, with default emission factors used to estimate CH₄ and N₂O emissions per tonne of waste combusted.

$$PE_{COM_CH_4,N_2O,c,y} = Q_{waste,c,y} \times (EF_{N_2O,t} \times GWP_{N_2O} + EF_{CH_4,t} \times GWP_{CH_4})$$

Where:

$PE_{COM_CH_4,N_2O,c,y}$ = Project emissions of CH₄ and N₂O from combustion within the project boundary associated with combustor c in year y (t CO₂)

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

$EF_{N_2O,t}$ = Emission factor for N₂O associated with waste treatment process t (t N₂O/t waste)

$EF_{CH_4,t}$ = Emission factor for CH₄ associated with treatment process t (t CH₄/t waste)

GWP_{N_2O} = Global Warming Potential of nitrous oxide (t CO₂e/t N₂O)

GWP_{CH_4} = 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

$$PE_{COM_CH_4,N_2O,c,y} = Q_{waste,c,y} \times (EF_{N_2O,t} \times GWP_{N_2O} + EF_{CH_4,t} \times GWP_{CH_4})$$

$$PE_{COM_CH_4,N_2O,c,y} = 420,000 \times (0.0000605 \times 273 + 0.000000242 \times 27)$$

$$PE_{COM_CH_4,N_2O,c,y} = 6939.67 \text{ tCO}_2$$

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

The emissions from electricity use are calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (TOOL05). However, the tool is not applicable if captive renewable power generation is used in the project activity or baseline scenario.

For this project in Ethiopia, where the grid emission factor is zero, the total project emissions from electricity consumption are zero.

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

Fossil fuel use in the project is calculated using TOOL03: Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion. The emissions are calculated using the following formula:

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

Where:

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

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

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

The CO₂ emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO₂ emission factor of the fuel type i = 3.1863

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

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

$$PE_{FC,j,y} = 350 \times 3.1863$$

$$PE_{FC,j,y} = 1115.2 \text{ tCO}_2$$

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

If wastewater is treated anaerobically, the associated emissions are handled in the anaerobic digestion section. Since there is no wastewater treatment in the project outlined, this section is not relevant.

Summary:

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

$$= PE_{INC,y} + PE_{AD,y}$$

$$= 52,229 + 3458$$

$$= 55,686 \text{ tCO}_2\text{e per year.}$$

Ex-post Project Emissions:

The ex post Project emissions are calculated in accordance with the applied methodology. The monitored values are as follows:

Monitoring Period	Project Emissions (tCO ₂ e)
01/01/2020 to 31/12/2020	54,796
01/01/2021 to 31/12/2021	19,662
01/01/2022 to 31/12/2022	8,618
01/01/2023 to 31/12/2023	8,851
01/01/2024 to 31/12/2024	9,075
Total	1,01,002

3.2.12 Leakage

Ex-ante Leakage Emissions:

As per the applied methodology ACM0022 v3.0^{4/}, leakage emissions are calculated as per the following:

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

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 $LE_y = LE_{AD,y}$

$$LE_y = 4661 \text{ tCO}_2\text{e per year}$$

Parameters involved in the calculation of the Leakage emissions:

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

Emissions associated with anaerobic digestion, including emissions from storage and composting of digestate.

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

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

$$\begin{aligned} LE_{AD,y} &= 4661.35 + 0 \\ &= 4661.35 \text{ tCO}_2\text{/year} \end{aligned}$$

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

Emissions caused by the storage of digestate under anaerobic conditions, which may lead to methane emissions due to further decomposition of organic matter.

For liquid digestate, the methodology uses Option 2 (default value method):

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

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)

$$LE_{storage,y} = 0.15 * 1150.95 * 27$$

$$= 4661.35 \text{ tCO}_2\text{e per year}$$

Ex-post Leakage Emissions:

The leakage emissions for the monitoring period are calculated as same as the ex ante, which results in the value of :

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

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 $LE_y = LE_{AD,y}$

Monitoring period	Leakage tCO ₂ e
01/01/2020 to 31/12/2020	3,208
01/01/2021 to 31/12/2021	3,499
01/01/2022 to 31/12/2022	3,353
01/01/2023 to 31/12/2023	4,666
01/01/2024 to 31/12/2024	4,374
Total	19,100

3.2.13 Net GHG emission reductions

Ex-Ante Net GHG emission reductions:

The calculation of net GHG emission is calculated as follows:

The emission reduction (ER_y) calculations are as follows:

$$ER_y = BE_y - PE_y - LE_y$$

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)

The ER_y for 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	1,28,239	55,686	4,661	67,891
Year 3	1,59,208	55,686	4,661	98,860
Year 4	1,85,789	55,686	4,661	1,25,442
Year 5	2,08,668	55,686	4,661	1,48,321
Year 6	2,28,418	55,686	4,661	1,68,070
Year 7	2,45,519	55,686	4,661	1,85,171
Year 8	2,60,372	55,686	4,661	2,00,025
Year 9	2,73,318	55,686	4,661	2,12,970
Year 10	2,84,638	55,686	4,661	2,24,290
Total	20,66,235	5,56,864	46,613	14,62,757
Average	2,06,624	55,686	4,661	1,32,978

Ex-post Net GHG emission reductions:

The calculation of net GHG emission is calculated as follows:

The emission reduction (ER_y) calculations are as follows:

$$ER_y = BE_y - PE_y - LE_y$$

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)

The ER_y for the first monitoring period (01-Jan-2020 to 31-Dec-2024):

Monitoring period	Baseline scenario(tCO ₂ e)	Project scenario(tCO ₂ e)		Net reduction(tCO ₂ e)
	GHG emissions	GHG emissions	Leakage	
01/01/2020 to 31/12/2020	89,882	54,796	3,208	31,878
01/01/2021 to 31/12/2021	75,047	19,662	3,499	51,886
01/01/2022 to 31/12/2022	61,779	8,618	3,353	49,808
01/01/2023 to 31/12/2023	1,08,099	8,851	4,666	94,582
01/01/2024 to 31/12/2024	1,32,115	9,075	4,374	1,18,666
Total	4,66,922	1,01,002	19,100	3,46,820

3.2.14 Re-evaluation of the baseline scenario

Not applicable, the project is undergoing joint validation and verification, the baseline is the valid until the first crediting period.

3.2.15 Natural disturbances and other catastrophic events

During the onsite visit, it has been confirmed that the project activity was not affected by any natural disturbances, such as droughts, fires, or floods, nor by catastrophic events, including wars, vandalism, or third-party interference. The project has demonstrated consistent operational stability throughout the monitoring period, with no external factors disrupting its implementation or performance.

4 Legal and documentary issues

4.1 Legal requirements

The CCMP (Climate Change Mitigation Project) demonstrates comprehensive alignment with Ethiopia's governing laws, statutes, and regulatory frameworks related to waste management and environmental protection. The project aligns with local, regional, and national legislation and adheres to international conventions, ensuring compliance with the No Net Harm principle. Below is a detailed assessment:

1. Compliance with National and International Conventions

- **Basel Convention (2000):** Ratification of the Basel Convention ensures Ethiopia's commitment to controlling the transboundary movements of hazardous waste. The CCMP does not involve hazardous waste transportation, ensuring no conflict with the Convention's requirements.
- **Rotterdam Convention (2003):** This international convention regulates the import and transportation of hazardous chemicals. The project remains compliant as it does not involve the use or transportation of restricted substances.

2. Compliance with National Legislation

- **Ethiopian Constitution:** The CCMP aligns with the constitutional aim of providing a clean and healthy living environment, as it focuses on the sustainable management of municipal solid waste.
- **Environmental Policy in Ethiopia, 1997:** The project complies fully with this policy, as its objective to manage municipal solid waste aligns with the policy's goals of promoting environmental sustainability and safeguarding public health.
- **Solid Waste Management Proclamation No. 513/2007:** This proclamation establishes the regulatory framework for municipal solid waste management. The CCMP aligns with its objectives by adhering to structured waste collection, treatment, and disposal processes.

3. Regional and Local Compliance

Regulation No. 100/2018 (Revised ISWM Regulation) and Regulation No. 54/2012 (Code Enforcement of Addis Ababa City Government): These local regulations specifically outline the roles of the Addis Ababa City Government in waste management. The CCMP directly supports the city's integrated solid waste management system, ensuring total compliance through effective collaboration with the Addis Ababa City Municipal Authority (AACMA).

4. Concrete Actions Supporting Compliance

The CCMP has demonstrated adherence through:

- Implementation of structured waste segregation, collection, and treatment to manage municipal solid waste effectively.
- Avoidance of hazardous waste handling or transportation, ensuring alignment with both national and international conventions.
- Collaboration with municipal and regional authorities to ensure adherence to localized regulations.

Rule or law	Type (legal, environmental, other)	Applicability/Compliance (full 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 objective is management of municipal solid wastes
Solid Waste Management Proclamation No. 513/2007"	Environmental	Total	The project complies as objective is management of municipal solid wastes
Regulation No. 100/2018 Revised ISWM Regulation" and "Regulation No. 54/2012	Environmental	Total	The project complies as objective is management of municipal solid wastes generated in Addis Ababa.

Code En- forcement of Addis Ababa City Govern- ment”			
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4.2 Link to the NDCs

The Emission reductions by the CCMP will not be traded for the use of NDC.

4.3 CCMP Documentation

In accordance with the requirements of the applicable methodology and as a foundation for his monitoring plan, which is evaluated in section 9 of this report, the license's information and data control system is validated for use during his first accreditation period.

The information and data control system seeks to reduce the hazards brought on by inaccurate GHG emission reduction estimate statements.

The following factors have been taken into account during the evidence gathering processes to assess the performance of the information and data control system as well as the design of the CCMP in this validation stage:

- The selection and management of GHG data and information;
- The processes for collecting, processing, consolidating and reporting GHG data and information.
- Systems and processes that ensure the validity and accuracy of GHG data and information;
- The design and maintenance of the GHG information system;
- Systems, processes, and personnel that support the GHG information system, including activities to ensure data quality;
- The results of maintenance and calibration of equipment and instruments;

Based on quantitative and qualitative data on the application of the requirements of the references stated in section 2.2 of this report, the validation of the CCMP-related paperwork submitted by the CCMP holder was done. The PDD's numbers are quantitative information; qualitative data comprises internal management controls, calculation methods, and socio-environmental effects of the CCMP.

To confirm that the claims made by the PP in their paperwork are credible, verifiable, and accurate, the information given by the CCMP owner was compared with main information sources and secondary information sources.

In addition to the review mentioned in the preceding paragraphs, the audit team greatly benefited from the interviews in gathering tests and evidence that strengthened the evaluation process.

5 Stakeholder consultation

The methods used for stakeholder consultation before the construction of the project, as well as the process of incorporating stakeholder feedback. These aspects are critical for ensuring transparency, inclusivity, and alignment with best practices in project development and validation.

Prior to the project's construction, the consultation process primarily involved information dissemination and questionnaire surveys. These methods allowed the public to access detailed information about the proposed project, raise concerns, and provide suggestions. By using these mechanisms, the project ensured that stakeholders were adequately informed and had opportunities to express their views. This approach demonstrates a commitment to inclusivity and stakeholder engagement, both of which are essential elements for obtaining social acceptance and compliance with environmental and social standards.

The identification of relevant stakeholders further enhances the credibility of the process. Stakeholders play a vital role in highlighting potential social, environmental, or operational risks associated with the project. The fact that a stakeholder meeting was conducted on 10th January 2014 is significant, as it provided a platform for direct interaction between the project developers and the local community. This meeting likely facilitated a deeper understanding of stakeholder concerns and enabled the collection of valuable feedback.

The statement also confirms that stakeholder feedback was considered in the project planning and implementation phases. This is a critical step in ensuring that the consultation process is not merely procedural but genuinely influences project outcomes. Addressing stakeholder concerns not only improves the project's design but also enhances its long-term sustainability by fostering trust and collaboration with local communities.

In conclusion, the stakeholder consultation process for this project appears to have been conducted in a transparent and inclusive manner. The use of information distribution, surveys, and stakeholder meetings demonstrates a thorough approach to engaging local stakeholders. By considering stakeholder feedback, the project aligns with best practices in project validation and ensures that local concerns are addressed effectively.

6 Uncertainty

The application of IPCC default values and associated discount factors in the calculations is consistent with applied methodology and ensures a standardized approach. The aggregate uncertainty reflects the combined uncertainties in activity data, emission factors, projection methods, and all subsequent factors used in the calculations. Adherence to ISO/IEC Guide 98-3 for assessing and expressing measurement uncertainty is critical to ensure the accuracy and reliability of the results.

Activity Data:

The accuracy and credibility of activity data are fundamental to the emission reduction calculations. The data sources must be transparent, reliable, and representative of the specific context of the project. Where data gaps exist, assumptions should be clearly documented and conservatively applied to avoid overestimating mitigation outcomes. Comparing the activity data with national or regional datasets or with data from similar projects can further enhance its validity.

Emission Factors:

The use of IPCC default emission factors ensures global consistency. However, as these factors are generalized, they may not always represent the specific local conditions of the project. Where feasible, locally derived emission factors should be preferred to reduce uncertainty. If local values are unavailable, conservative discount factors must be applied to account for the potential variability and limitations of default values.

Projection Methods:

The methodology for projecting future emissions or mitigation scenarios must be robust and suited to the project's context. Assumptions regarding baseline scenarios, growth rates, or technological advancements should be conservative and supported by credible evidence. The transparency of the projection process is vital for building confidence in the estimated mitigation outcomes.

Subsequent Factors in Calculations:

Additional parameters, such as oxidation rates, decay rates, or temperature corrections, must also be carefully evaluated. These factors, which influence the final results, should align with IPCC guidelines and be clearly documented to ensure consistency and transparency.

Assessment of Aggregate Uncertainty:

Quantifying the aggregate uncertainty as the product of the individual uncertainties is critical. This approach, as outlined in ISO/IEC Guide 98-3, provides a systematic framework for understanding the combined uncertainties. Sensitivity analysis can further support the validation process by demonstrating how variations in key input parameters impact the overall mitigation results.

In conclusion, while the use of IPCC default values and discount factors provides a strong basis for the calculations, a rigorous review of the uncertainties in each component is necessary to ensure the reliability of the results. By adhering to ISO/IEC Guide 98-3, documenting all assumptions, and applying conservative approaches, the VVB can ensure the credibility of the mitigation outcomes and their alignment with international standards.

7 Contributions to the UN's Sustainable Development Goals

The RWEPP CCMP demonstrates a clear alignment with the Sustainable Development Goals (SDGs) through its contributions to sustainability and climate change mitigation. The application of the Cercarbono SDG Tool is evident, and the project activity has been assessed in accordance with its guidelines. Below is a detailed review of the relevance and justification of SDGs associated with the project:

Application of Cercarbono's SDG Tool

The CCMP has applied the Cercarbono SDG Tool effectively to evaluate its impact on sustainable development goals.

The project provides evidence of its alignment with specific SDGs, supported by measurable contributions such as waste-to-energy conversion, reduction of greenhouse gas emissions, and social and economic benefits.

The submission of the assessment to the Validation Body further reinforces compliance with established standards and procedures.

Contributions to SDGs:

SDG 3: Good Health and Well-being

The CCMP addresses public health concerns by reducing methane emissions from open dumping of solid waste. Proper waste treatment mitigates the spread of diseases, contributing to improved health outcomes for surrounding communities.

SDG 8: Decent Work and Economic Growth

The project generates employment opportunities in waste collection, processing, and energy production. These activities contribute to local economic development and provide sustainable livelihoods for community members.

SDG 11: Sustainable Cities and Communities

By converting municipal solid waste into energy, the CCMP supports effective urban waste management. This reduces reliance on open landfills, thereby promoting cleaner, more sustainable urban environments.

SDG 13: Climate Action

The CCMP mitigates climate change by reducing greenhouse gas emissions from open landfills. The utilization of waste for energy production aligns with efforts to limit global temperature rise and supports national climate goals.

Each SDG aligns with specific aspects of the project, from environmental impacts to socio-economic benefits, demonstrating the holistic sustainability approach.

The RWEPP CCMP has applied the Cercarbono SDG Tool to assess its contributions to the SDGs, with evidence of alignment submitted to the Validation Body. The SDGs identified—SDG 3, SDG 8, SDG 11, and SDG 13—are directly relevant to the project activities, reflecting its positive impact on public health, economic growth, urban sustainability, and climate change mitigation. This alignment underscores the CCMP's commitment to advancing sustainability and addressing global challenges.

8 Grouped project

This is not a grouped project.

9 CCMP monitoring plan

The monitoring plan for the project activity has been reviewed with a focus on its design, implementation, and compliance with the requirements of the selected methodology and Cercarbono's Protocol. The plan aims to ensure reliable data collection, processing, and reporting, which are critical for verifying greenhouse gas (GHG) emission reductions. Below is a detailed assessment:

Data and parameters available at validation and fixed ex-ante in the baseline scenario:

Data/Parameter	Φ_{default}
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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
VVB Opinion	The VVB has reviewed the provided data for the model correction factor (Φ_{default}), which is used to account for model uncertainties in the calculation of emissions from solid waste disposal sites (SWDS). The information is well-structured and provides a clear understanding of how this correction factor is applied in emissions modeling. The source of the data is the Tool to calculate “Emissions from solid waste disposal sites”, which ensures reliability and consistency with established methodologies. The default value applied in the model is 0.85. However, for project or leakage emissions, the factor is set to 1, which aligns with standard practices to ensure conservative emission estimates. Additionally, a table is provided to determine the appropriate correction factor based on climate conditions and the application type (A or B). The values range from 0.75 to 0.85, depending on whether the site is in humid/wet or dry conditions and the tool's application type. This differentiation ensures that the model remains adaptable to varying environmental conditions, improving accuracy in emissions estimations. The choice of data and measurement methods is appropriate, as it provides clear guidelines on selecting the correction factor based on site-specific conditions. The structured approach enhances transparency and allows for consistency in emissions calculations. Based on the review, the data for Φ_{default} is comprehensive, and is used in emissions calculations
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.
VVB Opinion	The VVB has reviewed the provided data for the parameter y_f, which represents the fraction of methane captured at the solid waste disposal site (SWDS) and flared, combusted, or used in a manner that prevents its release into the atmosphere. The documentation is clear and aligns with established methodologies for emissions calculations. The source of data selection is maximum value is chosen based on (a) contractual or regulatory requirements mandating methane destruction or use, if applicable, and (b) historical data on methane capture. However, in this case, the applied value for y_f is 0, as there was no methane capture or flaring activity at the SWDS before the project. Additionally, no contracts or regulations exist that require methane destruction, justifying the assigned value. This is a conservative approach, ensuring that baseline emissions calculations accurately reflect the pre-project scenario without overestimating methane mitigation. The monitoring frequency is set to annual monitoring, which is appropriate for tracking any changes in methane capture over time. The measurement method relies on physical checks, ensuring direct verification of methane capture activities (if any) at the SWDS.

	The purpose of this data is to calculate baseline emissions calculations. Since $f_y = 0$, it confirms that no methane capture or flaring occurred before the project, reinforcing the integrity of the emissions baseline. This aligns with the principle of conservative emissions estimation, ensuring that any reductions attributed to the project are real and additional. Based on the review, the data for f_y is transparent, and suitable for use in emissions calculations.
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Data/Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	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
VVB Opinion	The VVB has reviewed the provided data for the oxidation factor (OX), which represents the proportion of methane from solid waste disposal sites (SWDS) that is oxidized in the soil or other covering material before reaching the atmosphere. This parameter plays a crucial role in baseline emissions calculations by accounting for the natural methane oxidation process facilitated by methanotrophic bacteria. The data is sourced from an extensive review of published literature, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, which is a widely recognized and credible source for greenhouse gas (GHG) emissions accounting. The application of an oxidation factor of 0.1 is consistent with the default values recommended by the IPCC for SWDS with some cover material. This enhances the reliability and accuracy of the parameter in emissions calculations. The additional comment clarifies the role of the oxidation factor, distinguishing it from the methane correction factor

(MCF). While OX accounts for the oxidation of methane as it passes through the landfill cover, MCF addresses the prevention of methane formation due to air intrusion. This distinction ensures a more accurate assessment of methane emissions and prevents potential double counting of emission reductions.

Although no specific measurement methods or procedures are outlined for OX, this is acceptable given that oxidation factors are typically derived from literature rather than site-specific measurements.

The purpose of this parameter is to calculate baseline emissions calculations, ensuring that methane oxidation is properly accounted for, leading to a more accurate estimation of net methane emissions from the SWDS. The applied value of 0.1 is reasonable, conservative, and aligns with standard methodologies.

Based on the review, the oxidation factor (OX) data is appropriate for use in emissions calculations.

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).
VVB Opinion	The VVB has reviewed the provided data for the Global Warming Potential of methane (GWP_{CH4}), which represents the conversion factor used to express methane (CH₄) emissions in terms of carbon dioxide equivalent (CO₂e). This parameter is essential for ensuring consistency and comparability in greenhouse gas (GHG) emissions accounting. The source of data is the Intergovernmental Panel on Climate Change (IPCC), which is the leading authority on climate science. The applied value of 27 t CO₂e/t CH₄ is derived from the

IPCC Sixth Assessment Report (AR6), which reflects the most up-to-date scientific understanding of methane's impact on global warming over a 100-year time horizon. Using the latest IPCC-recommended values ensures alignment with the applied methodology and enhances the accuracy of emissions calculations.

Although no specific measurement methods or procedures are outlined, this is appropriate given that GWP values are derived from scientific assessments rather than direct measurements. The default value of 27 is consistent with the latest climate science and provides a standardized approach to calculating methane's contribution to overall emissions. This ensures that emissions estimates remain comparable across projects, sectors, and reporting frameworks.

The **GWP_{CH₄}** parameter is a crucial factor in baseline emissions calculations, as it directly influences the estimated impact of methane emissions from solid waste disposal sites (SWDS). The applied value aligns with current international guidelines, ensuring that emission reduction calculations are based on the most recent and scientifically validated information.

Based on the review, the **GWP_{CH₄}** data is appropriate for use in emissions accounting.

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
VVB Opinion	The VVB has reviewed the provided data for the fraction of methane in the solid waste disposal site (SWDS) gas (F). This parameter represents the proportion of methane in the gas mixture generated from the biodegradation of organic waste. It is a critical factor in calculating baseline emissions, as methane is a potent greenhouse gas with a significantly higher global warming potential than carbon dioxide.

The source of data is the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which is a globally recognized and scientifically validated reference for emissions calculations. The applied value of 0.5 (50% methane by volume in landfill gas) is consistent with IPCC default values and widely accepted in landfill gas modeling. This ensures that the parameter aligns with monitoring methodology, enhancing the accuracy and reliability of emissions estimations.

The choice of data and measurement methods follows the IPCC 2006 Guidelines, which are considered a reliable source for default values. While site-specific methane content can vary based on waste composition, landfill conditions, and operational practices, using the IPCC default value provides a conservative and standardized approach. This ensures consistency across different projects and avoids overestimating methane emissions.

The purpose of this data is for baseline emissions calculation, ensuring that the methane fraction is appropriately accounted for when estimating total methane generation from SWDS. The additional comment correctly explains that methane is produced alongside carbon dioxide during the biodegradation of organic material, reinforcing the scientific basis for this parameter.

Based on the review, the fraction of methane in SWDS gas (**F**) is appropriate for use in emissions calculations.

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
VVB Opinion	The VVB has reviewed the provided data for the default fraction of degradable organic carbon (DOC) in municipal solid

waste (MSW) that decomposes in a solid waste disposal site (SWDS), represented as $\text{DOC}_{f,\text{default}}$. This parameter is essential for estimating methane generation from SWDS, as it determines the proportion of organic carbon in waste that actually degrades and contributes to methane emissions.

The source of data is the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which is a widely recognized and scientifically validated reference for greenhouse gas (GHG) emissions calculations. The applied value of 0.5 is consistent with IPCC recommendations and reflects the fact that not all organic carbon in MSW decomposes at the same rate, with some portions remaining stable or decomposing very slowly over time. Using this default value ensures that emissions estimates are aligned with monitoring methodology and provide a conservative yet realistic representation of landfill methane generation.

The choice of data and measurement methods follows the methodology specified in the emissions calculation tool, which states that the default value of 0.5 can be used for Application B if the tool is applied to MSW. This ensures consistency in applying the factor across different landfill projects while maintaining methodological integrity. The restriction on using this value only for Application A or for Application B in cases where MSW is being assessed helps prevent misuse of the parameter in contexts where a more site-specific approach may be required.

The purpose of this parameter is for baseline emissions calculation, ensuring that methane generation potential is estimated accurately while considering the fact that some organic material in waste does not fully decompose. This factor plays a key role in avoiding overestimation of methane emissions, as it acknowledges that a portion of the degradable organic carbon remains in the landfill over long periods.

Based on the review, the $DOC_{f,default}$ parameter is appropriate for use in emissions modeling.

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	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
VVB Opinion	Glass, plastic, metal, other inert waste	0
	The VVB has reviewed the provided data for the fraction of degradable organic carbon (DOC) in different waste types (DOC_j), which is a key parameter in estimating methane emissions from solid waste disposal sites (SWDS). DOC_j determines the proportion of organic carbon in various waste streams that can degrade and contribute to methane generation. This parameter plays a crucial role in ensuring accurate baseline emissions calculations. The source of data is the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, Tables 2.4 and 2.5), which is a globally recognized and scientifically validated reference for emissions accounting. The use of default DOC_j values	

ensures consistency with the applied methodology and provides a standardized approach for calculating emissions from municipal solid waste (MSW). The values applied are based on wet waste concentrations, which reflect the organic content of waste as delivered to the landfill, making them practical and applicable to real-world conditions.

The choice of data and measurement methods follows IPCC guidelines, which specify different **DOC_j** values for various waste types. The table provided lists default values for **DOC_j** based on waste composition:

- Wood and wood products – 43%
- Pulp, paper, and cardboard – 40%
- Food waste, beverages, and tobacco – 15%
- Textiles – 24%
- Garden, yard, and park waste – 20%
- Glass, plastic, metal, and inert waste – 0% (considered non-degradable)

Since only MSW is processed in this project, the default **DOC_j** values for MSW waste types have been applied. This is an appropriate approach, as it ensures that only relevant waste streams are considered in emissions calculations, preventing over- or underestimation of methane generation potential.

The purpose of this parameter is for baseline emissions calculation, ensuring that the methane generation potential of waste is accurately represented. The ignition loss test method, as described in BS EN 15169:2007, is referenced as a potential procedure for determining organic content, but it is noted that the IPCC's dry waste basis values are not practical for this specific project. The decision to use wet waste values aligns with practical landfill operations and ensures that the data remains applicable to real-world conditions.

Based on the review, the **DOC_j** parameter is suitable for use in emissions calculations.

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.
VVB Opinion	The VVB has reviewed the provided data for the methane correction factor (MCF_{default}), which accounts for the extent to which solid waste disposal sites (SWDS) operate under aerobic or anaerobic conditions. This parameter is essential in baseline emissions calculations, as it ensures a realistic estimation of

methane generation by recognizing that unmanaged or shallow landfills produce less methane due to increased aerobic degradation.

The source of data is TOOL04, which is used for calculating emissions from solid waste disposal sites. TOOL04 provides specific default MCF values based on landfill management practices and depth, ensuring a standardized approach for different landfill conditions. The methodology distinguishes between various types of SWDS based on waste placement, cover material, and gas control systems:

- for anaerobic managed SWDS – These landfills have controlled waste placement, compaction, and cover material, leading to predominantly anaerobic conditions.
- 0.5 for semi-aerobic managed SWDS – These include structured ventilation and leachate drainage systems that introduce oxygen, reducing methane production.
- 0.8 for unmanaged deep SWDS (≥ 5 meters deep) – These lack proper management but still develop anaerobic zones.
- 0.4 for unmanaged shallow SWDS (< 5 meters deep) – These have more aerobic decomposition, resulting in lower methane production.

For this project, the selected MCF value is 1.0, indicating that the SWDS is an anaerobic managed landfill. This means the landfill includes controlled waste deposition, cover material, compaction, or leveling, creating an oxygen-limited environment that promotes methane generation. The selection of this value is consistent with the project conditions and ensures an accurate representation of methane emissions.

The choice of data and measurement methods follows TOOL04 guidelines, ensuring that the methane correction factor is applied appropriately based on landfill characteristics. The pur-

pose of this parameter is for baseline emissions calculation, ensuring that methane generation potential is correctly estimated by considering landfill management practices.

The additional comment clarifies that MCF accounts for the fact that unmanaged SWDS produce less methane due to aerobic decomposition in the top layers. If a water table exists above the landfill base, a larger portion of the SWDS may be anaerobic, which could influence the MCF value. However, no water table concerns have been indicated for this project, confirming that the MCF of 1.0 is appropriate.

Based on our review, the **MCF_{default}** parameter is correctly applied to the project.

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: <u>Default values for the decay rate (k_j)</u>					
	Waste type j		Boreal and Temperate (MAT≤20°C)		Tropical (MAT>20°C)	
			Dry (MAP/PET<1)	Wet (MAP/PET >1)	Dry (MAP<1000m)	Wet (MAP >1000mm)
	Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07

		Wood, wood products and straw	0.02	0.03	0.025	0.035
	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

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

VVB Opinion	The VVB has reviewed the provided data for the decay rate (k_j) of different waste types, which is a critical parameter in estimating methane emissions from solid waste disposal sites (SWDS). The decay rate represents the speed at which organic waste decomposes and releases methane, varying based on waste composition and climatic conditions. The source of data is the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, Table 3.3), a well-established international reference for emissions accounting. The applied values align with IPCC-recommended defaults, ensuring methodological consistency and credibility. The decay rate (k_j) is influenced by climatic conditions, particularly mean annual temperature (MAT) and mean annual precipitation (MAP). To account for these factors, the methodology categorizes waste types into slowly, moderately, and rapidly degrading materials and provides different decay rates based on the climate: 1. Slowly degrading waste (e.g., pulp, paper, cardboard, textiles, wood, straw): • Decay rates range from 0.02 to 0.07 depending on climate conditions. • Wood products have the slowest decay due to their lignin content. 2. Moderately degrading waste (e.g., garden and park waste): • Decay rates range from 0.05 to 0.17, increasing significantly in wet tropical climates. 3. Rapidly degrading waste (e.g., food waste, sewage sludge, beverages, tobacco): • Decay rates range from 0.06 to 0.40, with the highest values in warm and wet conditions.
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	For waste types that do not fit clearly into the provided categories, the methodology instructs project participants to select a conservative value (i.e., the one resulting in the lowest emissions estimate) or request a deviation. This ensures consistency and prevents overestimation of methane generation. For specific cases: • Empty Fruit Bunches (EFB), which have characteristics similar to garden waste, should use garden waste decay rate values. • Sludge from the pulp and paper industry should use a conservative value of 0.03, regardless of climate conditions, ensuring a conservative estimate of emissions. The decay rate (kj) is used in baseline emissions calculations, helping estimate the timing and extent of methane production from different waste types. Since methane generation occurs over time, the kj parameter ensures that emissions estimates reflect realistic decomposition patterns based on climate and waste type. These values should be based on long-term statistical data with proper references. The use of climatic data ensures that decay rate values are applied correctly, preventing errors in methane emissions estimation. The kj parameter is correctly applied to the project.
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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
VVB Opinion	The VVB has reviewed the Rate_{compliance} parameter, which represents the state-level compliance rate with the Municipal Solid Waste (MSW) Management Rules for a given year (y). This parameter is crucial in baseline emissions calculations as it helps assess whether solid waste management regulations are being effectively implemented, which in turn affects methane emissions from unmanaged disposal sites. The source of data is secondary sources, such as government reports, which provide official and reliable information on the compliance status of MSW regulations at the state level. The value applied is 0, meaning that there is no compliance with the MSW Management Rules in the project scenario. This assumption is conservative and ensures that baseline emissions are not underestimated by assuming higher compliance levels than what actually exists. Monitoring is conducted annually, ensuring that any changes in compliance over time are reflected in emissions calculations. No specific measurement methods and QA/QC procedures are provided, which means that compliance will be assessed based on available government data rather than direct project-level measurements. The purpose of this parameter is to calculate baseline emissions, which represent the emissions that would have occurred in the absence of the project activity. If compliance with MSW Management Rules were high, methane emissions from open dumping or poorly managed landfills would likely be lower. However, with Rate_{compliance} set at 0, it is assumed that waste management practices remain unregulated, leading to higher baseline emissions estimates. The Rate_{compliance} parameter is measured, and any required calculations are based on the measured values from government

sources. This ensures transparency and accuracy in determining the level of compliance with MSW rules.

Monitored Parameters:

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					
Values applied	Wx	01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024
	Annual Waste received(t/y)	41,0038	245,789	162,978	244,372	265,794
VVB Opinion	The VVB has reviewed the data and parameters associated with the total amount of solid waste disposed of or prevented from disposal in the Solid Waste Disposal Site (SWDS) for the period from Jan 1, 2020, to April 30, 2024. This parameter, denoted as W_x, is measured in metric tons (t) and is essential for determining baseline emissions. The data has been sourced from plant records, ensuring that it reflects actual operational conditions and waste management practices implemented at the facility. Upon examining the annual waste received during the specified time frames, we observe fluctuations in the quantities reported. For the period from, January 1, 2020, to December 31, 2020, saw an increase to 410,038 t. However, in 2021, the waste received significantly declined to 245,789 t, followed by a further reduction in 2022 to 162,978 t. In 2023, the waste received rebounded to 244,372 t, while for 2024, the recorded amount is 265,794 t. These variations could be attributed to					

operational changes, waste reduction initiatives, regulatory impacts, or external factors such as market dynamics and waste generation trends.

The frequency of monitoring and the measurement methods or procedures have not been explicitly defined in the provided data. However, considering that this data is critical for calculating baseline emissions, it is imperative that standardized and verifiable methodologies are employed. This ensures accuracy, consistency, and reliability in the reported figures. The purpose of this data is clear—it serves as a fundamental input for estimating greenhouse gas emissions associated with waste disposal. Therefore, ensuring the integrity of data collection and reporting processes is essential to maintaining compliance with sustainability standards and regulatory requirements.

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	2020		
	W _{j,x}	Percentage of Waste received	Compositions based on percentages
	Food waste	52.80%	2,16,500
	Paper	5.00%	20,502
	Textiles	2.20%	9,021
	Plastics	9.60%	39,364
	Glass-ceramics	1.30%	5,330
	Metal	1.30%	5,330
	Garden, yard and park waste	10.30%	42,234
	wood	3.00%	12,301
	Diapers & sanitary napkins	7.10%	29,113
	Others(Ash/fine waste and Miscellaneous)	7.40%	30,343
	Total	100%	4,10,038

2021		
W _{j,x}	Percentage of Waste received	Compositions based on percentages
Food waste	52.80%	1,29,777
Paper	5.00%	12,289
Textiles	2.20%	5,407
Plastics	9.60%	23,596
Glass-ceramics	1.30%	3,195
Metal	1.30%	3,195
Garden, yard and park waste	10.30%	25,316
wood	3.00%	7,374
Diapers & sanitary napkins	7.10%	17,451
Others(Ash/fine waste and Miscellaneous)	7.40%	18,188
Total	100%	2,45,789

2022		
W _{j,x}	Percentage of Waste received	Compositions based on percentages
Food waste	52.80%	86,052
Paper	5.00%	8,149
Textiles	2.20%	3,586
Plastics	9.60%	15,646
Glass-ceramics	1.30%	2,119
Metal	1.30%	2,119
Garden, yard and park waste	10.30%	16,787
wood	3.00%	4,889
Diapers & sanitary napkins	7.10%	11,571
Others(Ash/fine waste and Miscellaneous)	7.40%	12,060
Total	100%	1,62,978

2023		
W _{j,x}	Percentage of Waste received	Compositions based on percentages
Food waste	52.80%	1,29,028
Paper	5.00%	12,219
Textiles	2.20%	5,376
Plastics	9.60%	23,460
Glass-ceramics	1.30%	3,177
Metal	1.30%	3,177
Garden, yard and park waste	10.30%	25,170

wood	3.00%	7,331
Diapers & sanitary napkins	7.10%	17,350
Others(Ash/fine waste and Miscellaneous)	7.40%	18,084
Total	100%	2,44,372

2024		
$W_{j,x}$	Percentage of Waste received	Compositions based on percentages
Food waste	52.80%	1,29,777
Paper	5.00%	12,289
Textiles	2.20%	5,407
Plastics	9.60%	23,596
Glass-ceramics	1.30%	3,195
Metal	1.30%	3,195
Garden, yard and park waste	10.30%	25,316
wood	3.00%	7,374
Diapers & sanitary napkins	7.10%	17,451
Others(Ash/fine waste and Miscellaneous)	7.40%	18,188
Total	100%	2,45,789

VVB Opinion

The VVB concludes that the dataset related to $W_{j,x}$, which represents the total amount of waste avoided from being treated in landfills for the years 2020 through 2024. This data, recorded in metric tons (t) and sourced from plant records, is critical for assessing waste diversion efforts and calculating baseline greenhouse gas (GHG) emissions. By analyzing these figures, we can determine the effectiveness of waste management practices in reducing landfill disposal and mitigating methane emissions.

A review of the reported values indicates significant fluctuations in the total waste received annually. In 2020, the recorded waste was 410,038 t in 2020. However, in 2021, the total waste intake dropped significantly to 245,789 t, followed by a further decline in 2022 to 162,978 t. In 2023, the quantity increased again to 244,372 t, while 2024 recorded 2,45,789 t.

These variations could be influenced by factors such as operational changes, regulatory policies, waste reduction initiatives, or shifts in waste generation patterns.

The composition of waste remains relatively consistent across all years. Food waste is the dominant fraction, accounting for 52.8% of the total, followed by plastics (9.6%), garden, yard, and park waste (10.3%), and diapers & sanitary napkins (7.1%). The high proportion of biodegradable waste is particularly relevant for emissions calculations, as organic matter decomposing in landfills generates methane. The stability in composition percentages suggests that waste characterization methods have remained unchanged over time. However, it is essential to verify whether these values are determined through periodic sampling or if they are estimated based on historical data.

The monitoring frequency is continuous, with annual aggregation, ensuring that data is recorded regularly and compiled for yearly reporting. The QA/QC procedures include the use of a weighbridge for measuring waste, with annual calibration to maintain accuracy. While this ensures reliability in weight measurements, there is no explicit mention of how the composition percentages are determined. To enhance data credibility, it would be beneficial to document the methodology for waste classification, including details on sampling frequency and sorting procedures.

Data and parameters fixed ex-ante in the project scenario:

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 border="1"> <thead> <tr> <th>Waste type j</th><th></th></tr> </thead> <tbody> <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> </tbody> </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																								
VVB Opinion	The data presented pertains to the fraction of fossil carbon (FFC_j) in the total carbon content of different waste types, which is expressed as a percentage (%). This parameter is crucial for determining the proportion of fossil-derived carbon in municipal solid waste (MSW), which subsequently influences greenhouse gas (GHG) emission calculations. The source of this data is Table 2.4, Chapter 2, Volume 5 of the IPCC 2006 Guidelines, which provides recognized default values for various waste categories. The values applied for FFC_j in MSW are specific to different waste types. Paper and cardboard have a fossil carbon fraction of 5%, whereas textiles contain 50%. Food waste and wood are not assigned values, likely due to their predominantly biogenic nature. Garden and park waste have a fossil carbon fraction of 0%, reflecting their purely biological origin. Nappies contain 10% fossil carbon, while rubber and leather contain 20%. Plastics, being entirely fossil-derived, have a 100% fossil carbon fraction. Inert waste is also categorized with a 100% fossil carbon fraction. Metals and glass, while potentially containing																								

some fossil-origin carbon, are not commonly combusted, making their contribution to fossil carbon emissions negligible.

The source of the data is based on default values provided in the IPCC 2006 guidelines, ensuring consistency in emission calculations across different projects. These values serve as a standard reference for estimating project emissions related to waste incineration and landfill degradation.

The primary purpose of this data is to calculate the project emissions associated with waste management activities, specifically for determining the proportion of fossil-derived CO₂ emissions. This parameter is integral to the application of the balance method in emissions accounting.

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 border="1"> <thead> <tr> <th>Waste type j</th><th></th></tr> </thead> <tbody> <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> <tr> <td>Plastics</td><td>85</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>5</td></tr> </tbody> </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	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
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																								

VVB Opinion

The data parameter **FCC_j** represents the fraction of total carbon content in different waste types, expressed as a percentage (%). This parameter is critical for evaluating the carbon composition of municipal solid waste (MSW), which directly impacts greenhouse gas (GHG) emissions from waste management processes, such as incineration and landfill degradation. The data is sourced from Table 2.4, Chapter 2, Volume 5 of the IPCC 2006 Guidelines, ensuring that the values applied are internationally recognized and standardized for emissions estimation.

The default values provided for **FCC_j** vary across different waste categories. Paper and cardboard, textiles, and food waste all have a total carbon fraction of 50%, indicating their significant organic composition. Wood, a major component of construction and organic waste, has a slightly higher total carbon content at 54%. Similarly, garden and park waste have an **FCC_j** of 55%, reflecting their high organic matter content. Nappies, which contain a combination of organic and synthetic materials, have a substantially higher carbon content at 90%. Rubber and leather, often derived from both natural and synthetic sources, have a carbon content of 67%. Plastics, primarily composed of carbon-based polymers, have an **FCC_j** of 85%, reinforcing their significant role in carbon emissions when incinerated. Inert waste, which consists mainly of non-combustible materials, has a minimal total carbon fraction of 5%. Metals and glass, though they may contain traces of fossil-origin carbon, are not commonly combusted in waste processing systems and are therefore marked as “NA” (not applicable) in this dataset.

The source of data for **FCC_j** is based on the default values prescribed in the IPCC 2006 Guidelines, ensuring consistency, reliability, and international comparability in emissions calculations. The data serves as a fundamental input for project emission calculations, particularly in assessing carbon release from waste treatment and disposal activities. It provides a standardized basis for determining the total carbon content of waste

streams, which is essential for accurately quantifying emissions from waste incineration and anaerobic decomposition processes.

The primary purpose of this parameter is to calculate project emission calculations by establishing a clear understanding of the total carbon composition of different waste types. This information is crucial for applying the balance method in emissions accounting, ensuring compliance with environmental regulations and sustainability targets.

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%
VVB Opinion	The data parameter EFF_{COM,c,y} represents the combustion efficiency of a specific combustor (c) in a given year (y), expressed as a percentage (%). This parameter is critical for evaluating the effectiveness of waste incineration processes in project activities. Combustion efficiency is a key factor in determining the extent to which waste is fully oxidized during incineration, directly influencing greenhouse gas (GHG) emissions, particularly carbon dioxide (CO₂), methane (CH₄), and other pollutants. The efficiency of combustion directly affects the completeness of carbon conversion, which is essential for ensuring accurate emissions calculations. The source of this data is specific to the project activities and is determined through direct measurement. Unlike default values provided in standardized guidelines, this parameter relies on empirical data collected from operational conditions, making it a more precise reflection of real-world combustor performance. For the purpose of emissions calculations, a value of 100% is applied, indicating that the combustor achieves complete combustion with no unburned carbon residues. While this represents an ideal scenario, actual combustion efficiency

can be influenced by factors such as fuel composition, operating conditions, and maintenance practices.

Monitoring of **EFF_{COM,c,y}** is done annually to ensure that the combustor maintains optimal performance. Measurement methods and procedures must adhere to industry standards and be conducted by a qualified third party, ensuring accuracy, reliability, and compliance with environmental and regulatory frameworks. This approach minimizes the risk of underestimating unburned carbon residues, which could otherwise lead to inaccurate emissions reporting.

The primary purpose of this parameter is for the calculation of project emissions by establishing a reliable combustion efficiency rate. Accurate determination of **EFF_{COM,c,y}** is crucial in estimating the extent of fossil carbon oxidation in waste combustion processes, thereby ensuring that emissions calculations reflect real-world conditions. This parameter plays a significant role in determining CO₂ emissions from incineration activities and contributes to the overall assessment of a project's environmental impact.

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
VVB Opinion	The data parameter GWP_{N₂O} represents the global warming potential (GWP) of nitrous oxide (N ₂ O), expressed in tonnes of CO ₂ equivalent per tonne of N ₂ O (tCO ₂ e/tN ₂ O). This parameter is critical in quantifying the climate impact of N ₂ O emissions, which is a potent greenhouse gas (GHG) with a significantly higher warming effect than carbon dioxide (CO ₂). The value applied, 273, is sourced from the IPCC Sixth Assessment Report (AR6), ensuring alignment with the latest scientific consensus on GHG emissions accounting.

	The GWP of N₂O is derived from its radiative efficiency and atmospheric lifetime, making it a crucial factor in emissions calculations. The value of 273 indicates that one tonne of N₂O has the same global warming effect as 273 tonnes of CO₂ over a 100-year time horizon. This update from previous IPCC reports reflects advancements in climate science and improved understanding of N₂O's contribution to global warming. The primary purpose of this parameter is to calculate the project emissions. By applying the GWP_{N₂O} value, emissions from sources such as waste combustion, industrial processes, and other project-related activities that produce N₂O can be accurately converted into CO₂-equivalent emissions. This conversion is crucial for determining total project emissions, ensuring compliance with climate policies, carbon accounting frameworks, and sustainability reporting requirements.
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Data/Parameter	EF_{N₂O,t}
Data unit	t N ₂ O/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
VVB Opinion	The data parameter EF_{N₂O,t} represents the nitrous oxide (N₂O) emission factor from waste incineration, expressed in tonnes of N₂O per tonne of waste (wet basis) or as a fraction. This parameter is essential for estimating N₂O emissions from solid waste disposal sites (SWDS) where waste is either incinerated or otherwise processed. The data is sourced from Table 5.6, Chapter 5, Volume 5 of the IPCC 2006 Guidelines (ACM0022), ensuring that the values used are consistent with accepted methodologies for emissions estimation. The default value applied is 0.0000605 t N₂O/t waste, which serves as a reference for calculating emissions from waste combustion processes.

The emission factor varies depending on waste type and incineration technology. For municipal solid waste (MSW), the emission factors differ based on incineration methods:

- Continuous and semi-continuous incinerators: $1.21 \times (50 \times 10^{-3}) \text{ t N}_2\text{O/t waste}$
- Batch-type incinerators: $1.21 \times (60 \times 10^{-3}) \text{ t N}_2\text{O/t waste}$

For industrial waste, a single emission factor is applied across all types of incineration:

- $1.21 \times (100 \times 10^{-3}) \text{ t N}_2\text{O/t waste}$

For sludge waste, the emission factors are notably higher due to its composition:

- Sludge (excluding sewage sludge): $1.21 \times (450 \times 10^{-3}) \text{ t N}_2\text{O/t waste}$
- Sewage sludge: $1.21 \times (900 \times 10^{-3}) \text{ t N}_2\text{O/t waste}$

A conservativeness factor of 1.21 has been applied to account for uncertainties in the IPCC default values, ensuring that emissions estimates remain cautious and do not underestimate actual emissions. This factor is crucial in regulatory and compliance frameworks, where conservative estimates help mitigate risks associated with uncertainty in emission calculations.

The purpose of this data parameter is to calculate the project emissions, specifically for waste incineration processes. It is particularly relevant to Option 2 of the procedure to estimate $PE_{COM,c,y}$, a methodological approach for determining combustion-related emissions in waste management projects.

Data/Parameter	EF_{CH4,t}
Data unit	t CH4/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
VVB Opinion	The data parameter EFCH_{4,t} represents the methane (CH₄) emission factor associated with waste treatment process t, expressed in tonnes of CH₄ per tonne of waste (wet basis). This parameter is critical in quantifying methane emissions resulting from waste incineration, contributing to project emissions calculations. The value applied is 0.000000242 t CH₄/t waste, sourced from ACM0022, which follows methodologies aligned with IPCC 2006 Guidelines. For the continuous incineration of industrial waste, methane emission factors should be sourced from Volume 2, Chapter 2 (Stationary Combustion) of the IPCC 2006 Guidelines to ensure consistency with standardized emission calculation methodologies. The methane emission factor varies depending on waste type and incineration technology: <u>Municipal Solid Waste (MSW):</u> - Continuous incineration: - Stoker: $1.21 \times (0.2 \times 10^{-6})$ t CH₄/t waste - Fluidized bed: ~0 t CH₄/t waste (negligible emissions) - Semi-continuous incineration: - Stoker: $1.21 \times (6 \times 10^{-6})$ t CH₄/t waste - Fluidized bed: $1.21 \times (188 \times 10^{-6})$ t CH₄/t waste - Batch-type incineration: - Stoker: $1.21 \times (60 \times 10^{-6})$ t CH₄/t waste - Fluidized bed: $1.21 \times (237 \times 10^{-6})$ t CH₄/t waste

For other waste types, the methane emission factors are significantly higher:

- Sludge (semi-continuous or batch-type incineration):
 $1.21 \times (9,700 \times 10^{-6}) \text{ t CH}_4/\text{t waste}$
- Waste oil (semi-continuous or batch-type incineration):
 $1.21 \times (560 \times 10^{-6}) \text{ t CH}_4/\text{t waste}$

A conservativeness factor of 1.21 has been applied to account for uncertainties in the IPCC default values, ensuring a cautious approach in emissions estimation. This conservative adjustment prevents underestimation of methane emissions, which is crucial in regulatory compliance, carbon accounting, and sustainability reporting.

The primary purpose of this parameter is to calculate the project emissions, particularly those arising from the combustion of waste in various incineration systems. This parameter is specifically applicable to Option 2 of the procedure to estimate $PE_{com,c,y}$, ensuring that incineration-based project activities are accurately assessed for their CH_4 emissions impact.

In conclusion, $EF_{CH_4,t}$ is a key parameter for estimating methane emissions from waste incineration.

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
VVB Opinion	The data parameter $NCV_{i,y}$ represents the net calorific value (NCV) of the fuel used in the project, measured in gigajoules per tonne (GJ/t). This parameter is essential for calculating energy content and subsequent emissions from fuel combustion,

ensuring accurate quantification of project emissions. The applied value of 43 GJ/t is derived from Volume 2, Table 1.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Page 18), which provides default NCVs for various fuel types.

The net calorific value (NCV), also known as the lower heating value (LHV), represents the usable energy content of fuel after accounting for energy lost in vaporized water. This value is critical for estimating carbon dioxide (CO₂) emissions from combustion processes. The applied NCV of 43 GJ/t aligns with typical values for liquid fossil fuels, such as diesel and gasoline, ensuring compliance with recognized standards for greenhouse gas (GHG) emissions accounting.

The choice of measurement method requires the aggregation of electricity meter readings on a monthly and annual basis. These readings are archived during the crediting period and retained for an additional two years after the crediting period ends. This approach ensures data integrity, transparency, and traceability for verification and audit purposes.

The primary purpose of this parameter is to calculate the project emissions by determining the energy content of fuel used. This is a crucial step in emission reduction projects, particularly those related to energy efficiency improvements, fuel switching, and waste-to-energy initiatives.

In conclusion, the **NCV_{i,y}** parameter is a fundamental component of fuel combustion emissions calculations.

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

VVB Opinion

The data parameter $EF_{CO_2,i,y}$ represents the weighted average CO₂ emission factor for fuel type *i* in year *y*, measured in tonnes of CO₂ per gigajoule (tCO₂/GJ). This parameter is critical for quantifying carbon dioxide (CO₂) emissions resulting from fuel combustion within the project boundary. The applied value of 0.0741 tCO₂/GJ is sourced from Volume 2, Table 1.4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Page 23), which provides default CO₂ emission factors for various fuel types.

The CO₂ emission factor is an essential input for greenhouse gas (GHG) accounting, ensuring that fuel combustion emissions are calculated in accordance with applied methodology. The value applied (0.0741 tCO₂/GJ) aligns with standard emission factors for liquid fossil fuels, such as diesel or gasoline, reflecting their carbon intensity per unit of energy released. This standardized approach ensures comparability and consistency across projects using similar fuel types.

If actual fuel-specific CO₂ emission factors are available, they should be prioritized over default values to enhance accuracy. Specifically, if the fuel supplier provides both the NCV (Net Calorific Value) and the CO₂ emission factor on the invoice, and these values are based on direct measurements for the specific fuel, then that CO₂ factor must be used. In cases where a supplier-provided emission factor is unavailable, alternative sources such as nationally recognized datasets or accepted default values (as specified in Options (b), (c), or (d) of the methodology) should be applied.

The $EF_{CO_2,i,y}$ parameter is used for the calculation of project emissions, specifically in fuel combustion-related activities. This is particularly relevant for Option B, which applies when an emission factor is not directly available from the supplier. The parameter is also crucial for carbon crediting mechanisms, such as the Clean Development Mechanism (CDM) and other voluntary carbon markets, where accurate emissions accounting is required for project validation and verification.

	The $EF_{CO_2,i,y}$ parameter plays a fundamental role in carbon emissions accounting, ensuring alignment with IPCC methodologies.
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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	$NCV_{i,y} * EF_{CO_2,i,y}$
VVB Opinion	The data parameter $COEF_{i,y}$ represents the CO₂ emission coefficient for fuel type i in year y, measured in tonnes of CO₂ per unit of mass or volume. This parameter is crucial for quantifying CO₂ emissions from fuel combustion, ensuring accurate and standardized greenhouse gas (GHG) accounting in the project. The applied value is derived using the formula: $COEF_{i,y} = NCV_{i,y} \times EFCO_{2,i,y}$ Where: • $NCV_{i,y}$ is the net calorific value of fuel type i in year y, expressed in GJ per unit mass or volume. • $EFCO_{2,i,y}$ is the CO₂ emission factor of the fuel, expressed in tCO₂ per GJ. The source of data for this parameter is Volume 2, Table 1.4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Page 23), which provides default CO₂ emission factors for different fuel types. This ensures that calculations are consistent with international standards and can be used for comparable emissions estimations.

	The COEF_{i,y} parameter is primarily used to calculate project emissions by determining total CO₂ emissions per unit of fuel consumed. It plays a key role in carbon crediting mechanisms, such as the Clean Development Mechanism (CDM) and voluntary carbon markets, where precise emissions quantification is required. The COEF_{i,y} parameter is fundamental for project-level emissions calculations.
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Data/Parameter	EF_{CH4,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)
Values applied	0.028
VVB Opinion	The data parameter EF_{CH4,default} refers to the default emission factor for methane (CH₄) leakage from an anaerobic digester, expressed as t CH₄ leaked per t CH₄ produced. This factor is crucial for calculating the methane emissions from the project's anaerobic digestion process, particularly for projects involved in biogas production or waste treatment using digesters. The emission factor is sourced from multiple references, including the 2006 and 2019 IPCC Guidelines, Flesch et al. (2011), and Kurup (2003), ensuring that the data is grounded in widely accepted scientific literature and methodologies. The default values provided depend on the type of digester used in the project. The values for methane leakage vary as follows: • 0.028: For digesters with steel, lined concrete, or fiberglass construction and gas holding systems (e.g., egg-shaped digesters or monolithic construction). • 0.05: For UASB (Upflow Anaerobic Sludge Blanket) digesters with floating gas holders and no external water seal.

- 0.10: For digesters with unlined concrete, ferrocement, or brick masonry construction, including monolithic fixed-dome digesters and covered anaerobic lagoons.

In the project, the value of 0.028 is applied, which corresponds to a steel or lined concrete digester with a gas holding system. This value was chosen based on the type of digester used in the project, which is identified by manufacturer information. If such information is not available, the default value of 0.1 is applied as the upper range of the IPCC's recommended values.

The primary purpose of this parameter is to calculate project emissions of methane from the anaerobic digestion process. This is critical for projects aiming to reduce methane emissions through biogas recovery and flaring or utilization of the produced methane.

The measurement methods for determining methane leakage in anaerobic digesters depend on the specific digester technology used. The project must identify the digester type through manufacturer information, which is a critical step in ensuring the correct application of the corresponding default leakage factor. If the digester type cannot be verified, the higher leakage factor (0.1) should be used as a conservative estimate, ensuring that the emissions calculation remains on the safer side.

The $EF_{CH_4, default}$ parameter plays an essential role in accurately quantifying methane emissions from the anaerobic digestion process, which is critical for projects that aim to reduce GHG emissions through biogas production and utilization.

Data/Parameter	$Q_{biogas,y}$
Data unit	Nm3 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

VVB Opinion

The data parameter $Q_{\text{biogas},y}$ refers to the amount of biogas collected at the digester outlet in year y , measured in normal cubic meters (Nm^3). This parameter is essential for determining the methane emissions from the anaerobic digestion process, specifically for quantifying biogas production over the course of the project. The biogas collection data is critical for ex-ante project emission calculations, which estimate the expected emissions reductions and project performance in the future.

The applied value of 2,863,060 Nm^3 is derived from the project study report, which estimates that 7,844 Nm^3 of biogas are produced per day. This daily value is multiplied by 365 days to determine the annual biogas production, resulting in the total of 2,863,060 Nm^3 of biogas collected in a year. This calculation is straightforward and provides an estimate of biogas collection capacity based on the project's design or operational assumptions.

The $Q_{\text{biogas},y}$ value is used to calculate ex-ante project emissions, providing an estimate of the potential methane emissions that could occur based on the amount of biogas collected. This is important for projects that utilize biogas for energy generation or methane flaring, as it enables the project to forecast emissions reductions.

The monitoring frequency for $Q_{\text{biogas},y}$ is annually, which means that the total amount of biogas produced will be measured and reported once per year. Given that the biogas production can fluctuate throughout the year based on factors such as feedstock quality, temperature, and digester health, it is important that the project applies consistent measurement methods to ensure the accuracy and reliability of the reported values.

The $Q_{\text{biogas},y}$ parameter is a critical input for the calculation of ex-ante project emissions and the estimation of future methane emissions reductions.

Data/Parameter	$f_{\text{CH}_4, \text{default}}$
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
VVB Opinion	The data parameter $f_{\text{CH}_4, \text{default}}$ refers to the default volumetric fraction of methane (CH₄) in biogas, measured in m³ CH₄ per m³ of biogas, corrected to reference conditions. This value is important for calculating the amount of methane produced in the digester, which directly impacts the emissions calculations for the project. Methane is the primary greenhouse gas in biogas, and accurately determining its content is crucial for estimating the project's overall environmental impact and potential for emissions reduction. The value of 0.6 for the methane fraction is derived from reported values from registered projects and research papers (Davidsson, 2007). This value is considered a default based on general industry knowledge and peer-reviewed literature, which suggests that biogas typically consists of approximately 60% methane. It is important to note that this value is corrected to reference conditions, ensuring that variations in temperature and pressure do not affect the consistency of the data. The value of 0.6 aligns with the typical composition of biogas produced in anaerobic digestion processes, where methane is the dominant component. However, the actual methane content can vary depending on factors such as feedstock quality, digester conditions, and digester management, which might lead to differences in the methane fraction for specific projects. The $f_{\text{CH}_4, \text{default}}$ value is used in the context of Option 2 of the step "Determination of the quantity of methane produced in the digester". This step is crucial for estimating the amount of methane emissions that could be captured or flared, which is

important for projects focused on biogas utilization or methane recovery. The methane fraction is directly used in the emissions calculations to determine the amount of methane that is produced from the anaerobic digestion process and, subsequently, the project's emissions reductions.

By applying the default value of 0.6, the project can estimate the methane content of the biogas produced, which is used in further calculations to assess the project's carbon impact. This estimate is critical for forecasting potential emissions reductions and for reporting the project's environmental benefits, particularly when the methane is captured for energy use or flared.

As per the provided information, the monitoring frequency for this parameter is not specified. However, because this value is a default, it is generally not subject to direct measurement or monitoring on an annual basis. Instead, it is used as a static parameter in emissions calculations, assuming the methane fraction in the biogas remains relatively consistent throughout the project.

The $f_{CH_4, default}$ value of 0.6 is a widely accepted default for the methane fraction in biogas and is appropriate for estimating ex-ante project emissions in the absence of more specific data.

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
VVB Opinion	The parameter ρ_{CH_4} , representing the density of methane at reference conditions, has been reviewed for its accuracy and relevance in the context of ex-ante project emissions calculations. The unit of measurement, t CH ₄ /m ³ CH ₄ , ensures consistency with standard practices for quantifying methane density in emission-related assessments.

The data source is explicitly identified as TOOL08, a recognized methodology for calculating methane density under defined reference conditions. This ensures the reliability and methodological robustness of the parameter. The applied value of $0.00067 \text{ t CH}_4 / \text{m}^3 \text{CH}_4$ aligns with established scientific and engineering principles for methane density, demonstrating an appropriate selection for the given application.

The primary purpose of this parameter is to calculate the ex-ante project emissions, which is crucial for estimating potential greenhouse gas reductions and ensuring compliance with emission reduction methodologies. Given the significance of this data in emission quantification, it is essential that it remains consistent with approved calculation tools and methodologies.

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
VVB Opinion	The parameter $Q_{ww,y}$ represents the total amount of wastewater discharge generated by the project activity that is either treated anaerobically or released untreated during the year y. This parameter is essential for estimating methane emissions from wastewater management processes, as it directly influences the calculation of ex-ante project emissions. The unit of measurement, tCO₂e, aligns with standard greenhouse gas accounting methodologies, ensuring consistency in emissions estimation. The source of data is identified as the Feasibility Study Report (FSR), a key project document that typically includes detailed

	assessments of wastewater generation and treatment scenarios. The applied value of 57,092.5 tCO ₂ e is derived from this study, indicating a data-driven approach based on project-specific conditions. The use of the FSR as a reference ensures the credibility and transparency of the data, as feasibility studies are expected to follow industry-standard assessments and calculations.
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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	Given below
VVB Opinion	The parameter $p_{n,j,y}$ represents the weight fraction of each waste type j in the sample n collected during the year y. This parameter is fundamental for determining the composition of waste generated within the project boundary, as it directly influences the estimation of degradable organic carbon (DOC) and methane generation potential. The weight fraction is measured on a wet basis, ensuring consistency in waste composition analysis. The source of data is IPCC default values, providing a scientifically recognized foundation for waste composition analysis. The measurement methods involve sampling waste composition, categorizing the waste types as per the table for DOC_j and k_j, and weighing each fraction accordingly. The reported dry weight proportions of various waste types, including food waste (60.50%), paper/cardboard (8.50%), plastics (7.00%), and garden & park waste (5.00%), provide a detailed breakdown of waste composition for accurate emission calculations. The primary purpose of this parameter is to calculate the ex-ante project emissions, particularly in scenarios where waste composition significantly influences greenhouse gas emissions from landfill or treatment processes.

	The monitoring is required only for Application B, and sampling is not necessary if the waste consists of only one waste type. This condition ensures that the monitoring burden is proportionate to the complexity of the waste stream. Based on this review, the validation team confirms that the methodology and approach adopted for this parameter are appropriate for estimating waste composition and its impact on greenhouse gas emissions.
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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
VVB Opinion	The parameter P_{COD,y} represents the Chemical Oxygen Demand (COD) of the wastewater discharge generated by the project activity in a given year (y), measured in tCOD/m³. This parameter is essential for assessing the organic pollutant load in the wastewater and is a key factor in estimating project-related emissions. The data source for this parameter is the Feasibility Study Report (FSR), which provides the applied value of 0.0168 tCOD/m³. Monitoring of this parameter is conducted monthly, with values averaged annually to ensure a representative measurement over time. While specific measurement methods and procedures are not detailed, the data collection process will adhere to standard industry practices. Quality assurance and quality control (QA/QC) procedures include regular maintenance and testing of monitoring instruments to ensure accuracy and reliability in recorded values. This systematic approach ensures that deviations are identified and rectified in a timely manner, maintaining data integrity.

	The primary purpose of this parameter is to calculate the ex-ante project emissions, allowing for a comprehensive assessment of the environmental impact of wastewater discharge. However, it is important to note that if the wastewater discharge is treated aerobically, emissions from this source are assumed to be zero. In such cases, monitoring of $P_{\text{COD},y}$ is not required. This aligns with accepted methodologies, where aerobic treatment effectively neutralizes COD-related emissions, thereby reducing the monitoring burden while ensuring compliance with sustainability standards.
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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	The validation team, has reviewed the data parameter Methane Conversion Factor for Wastewater Treatment (MCF_{ww}) and its associated details. The MCF_{ww} is expressed as a fraction and is a key parameter used in the estimation of methane emissions from wastewater treatment processes. The source of this data is Table 6.3, Chapter 6, Volume 5 of the IPCC 2006 Guidelines, which is a widely recognized and authoritative reference for greenhouse gas (GHG) accounting. The choice of data follows the default values provided in these guidelines, ensuring consistency with the applied methodology. The applied default value is 1.0. The purpose of utilizing this parameter is to calculate the ex-ante of project emissions, particularly in the context of methane emissions from wastewater treatment facilities. By applying the default values, the methodology ensures a standardized approach that aligns with IPCC recommendations, reducing uncertainties associated with data collection and measurement.

Monitored parameters:

Data/Parameter	$Q_{\text{waste},c,y}$					
Data unit	T					
Description	Quantity of fresh waste fed into Incinerator in year y					
Source of data	Plant records					
Value(s) applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024
	Quantity of waste fed into combustor	229,621	81,111	35,855	36,656	37,211
VVB Opinion	The parameter $Q_{\text{waste},c,y}$ represents the quantity of fresh waste fed into the incinerator in a given year (y), measured in tonnes (T). This parameter is critical for determining the incineration process's contribution to project emissions. The primary source of data is plant records, which should ideally provide direct measurements of waste input into the combustion process. However, it is noted that the plant did not monitor this parameter directly. Instead, the quantity of waste fed into the incinerator was estimated based on the Project Progression Report published in April 2024, which provides incineration ratios against the total waste transported to the final disposal complex.					
	The reported values indicate a declining rate in incineration rates over the years. In 2020, the incineration ratio was to 56%, 33% in 2021, 22% in 2022, 15% in 2023, and 14% in 2024 . Based on these percentages, the waste quantities incinerated for the respective years were estimated as 229,621 T (2020), 81,111 T (2021), 35,855 T (2022), 36,656 T (2023), and 37,211 T Given the absence of direct monitoring, reliance on derived values introduces a level of uncertainty that should be addressed through improved record-keeping and verification methods.					

	The monitoring of $Q_{\text{waste},c,y}$ is expected to be conducted continuously, which is essential for ensuring accurate data collection. However, no specific measurement methods and procedures have been detailed. The QA/QC procedures indicate that the crane used for waste handling shall be calibrated according to the manufacturer's specifications. The primary purpose of monitoring $Q_{\text{waste},c,y}$ is to calculate the project emissions.
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Data/Parameter	Q _{j,c,y}					
Data unit	t					
Description	Quantity of fresh waste type j fed into combustor c the in year y (t)					
Source of data	Plant records					
Values applied	Waste type	01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024
	Wood	16,073	5,678	2,510	2,566	2,605
	Pulp, paper and car-dboard	17,681	6,246	2,761	2,822	2,865
	food waste	1,23,766	43,719	19,326	19,757	20,057
	Nappies	0	0	0	0	0
	Textiles	3,904	1,379	610	623	633
	Garden, yard and park waste	0	0	0	0	0
	Glass	5,281	1,866	825	843	856
	metal	4,133	1,460	645	660	670
	plastic	12,629	4,461	1,972	2,016	2,047
	rubber	2,526	892	394	403	409
	Other	26,636	9,409	4,159	4,252	2,605
VVB Opinion	The parameter Q _{j,c,y} represents the quantity of fresh waste type (j) fed into combustor (c) in year (y), measured in tonnes (t). This data is essential for evaluating the composition of waste incinerated and its impact on project emissions. The primary source of data is the plant records, which provides estimated waste quantities for various categories over the monitored period.					

The reported data includes multiple waste categories such as wood, pulp/paper/cardboard, food waste, textiles, glass, metal, plastic, rubber, and other mixed waste. Notably, nappies and garden waste were not recorded as part of the waste fed into the combustor. The data shows a declining trend in the total waste incinerated over time, consistent with the general reduction in waste incineration observed in the project. Food waste remains the largest category, accounting for a significant portion of the total waste incinerated. Other substantial contributors include paper-based waste, plastic, and mixed waste categories.

The monitoring frequency is noted as calculated, rather than directly measured. This implies that the values have been estimated rather than continuously recorded through direct monitoring instruments. While such an approach may be necessary in the absence of real-time measurement systems, it introduces a degree of uncertainty in the reported figures. Without explicit details on the methodology used to derive these calculations, data transparency and accuracy may be compromised.

The primary purpose of monitoring $Q_{j,c,y}$ is to calculate the project emissions, which depend on the specific waste composition and incineration efficiency. Given the reliance on FSR-based estimations, the validation team recommends implementing direct measurement methods where feasible. This may include weighing systems integrated into waste handling processes or real-time tracking of waste input by category. Additionally, detailed documentation on the calculation methodology should be provided to enhance verifiability and consistency in future assessments.

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.

Values Applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 30-04-2024	
	The quantity diesel combusted in process during the year (tonnes)	74,220	105,986	12,326	25,682	54,554	
VVB Opinion	The parameter $FC_{i,j,y}$ represents the quantity of fuel type (i) combusted in process (j) during year (y), measured in tonnes per year (t/year). This data is crucial for assessing fuel consumption trends and estimating the project's emissions. The source of data is on-site monitoring and measurement, ensuring real-time tracking of fuel use. However, it is noted that for 2020, the reported diesel consumption value was derived from the design capacity value published in the Project Specification Report, rather than actual consumption records. The recorded diesel consumption values indicate a fluctuating pattern, with a peak in 2021 (105,986 tonnes) followed by a significant decrease in 2022 (12,326 tonnes). This variation is because of possible changes in operational efficiency, waste incineration rates, or fuel sourcing strategies. The monitoring frequency is specified as “measuring when consumption happens,” which suggests that data collection is continuous. The primary purpose of monitoring $FC_{i,j,y}$ is the calculation of project emissions, where fuel combustion plays a significant role in determining carbon footprint and environmental impact.						
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	Plant records						
Value(s) applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024	
	Quantity of methane produced in the anaerobic digester(tons)	23.19	23.19	11.59	11.59	11.59	
VVB Opinion	The data provided pertains to the quantity of methane ($Q_{CH_4,y}$) produced in an anaerobic digester over multiple years, measured in tons of CO₂ equivalent (tCO₂e). The data is from 01-Jan-2020, to 31-Dec-2024, with annual values recorded for each year. The methane production data originates from the project proponent (PP), serving as a crucial parameter for calculating project emissions. Upon reviewing the values, we observe fluctuations in methane production across the years. The recorded methane generation was highest in 2020 and 2021 at 23.19 tons, followed by a significant reduction to 11.59 tons in 2022, 2023 and 2024. These variations may be attributed to operational changes, feedstock availability, or efficiency fluctuations in the anaerobic digestion process. Given that the primary purpose of this data is to calculate project emissions, its accuracy directly impacts the reliability of emissions reduction claims. In conclusion, while the provided data offers a useful basis for emissions calculations, further clarifications on data collection methods and potential influences on methane production variations are necessary.						

Data/Parameter	$F_{CH_4,RG,m}$
Data unit	Kg

Description	Mass flow of methane in the residual gas in the minute m																	
Source of data	Plant records																	
Value(s) applied	<table><tr><td></td><td>01-01-2020 to 31-12-2020</td><td>01-01-2021 to 31-12-2021</td><td>01-01-2022 to 31-12-2022</td><td>01-01-2023 to 31-12-2023</td><td>01-01-2024 to 31-12-2024</td></tr><tr><td>Mass flow(kg/min)</td><td>0.04475</td><td>0.04475</td><td>0.04475</td><td>0.04475</td><td>0.04475</td></tr></table>							01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024	Mass flow(kg/min)	0.04475	0.04475	0.04475	0.04475	0.04475
	01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024													
Mass flow(kg/min)	0.04475	0.04475	0.04475	0.04475	0.04475													
VVB Opinion	The provided data parameter, F_{CH4,RG,m}, represents the mass flow of methane in the residual gas per minute, expressed in kilograms (kg). The data is sourced from plant records and remains constant at 0.04475 kg/min for all recorded years, spanning from Jan 1, 2020, to Dec 31, 2024. This uniform value is due to the absence of continuous monitoring at the plant, leading to the application of a single annual value across multiple years. The calculation was based on a volumetric flow rate of 62.5 liters per minute, converted to mass flow using methane’s reference density of 0.716 kg/L. The calculation methodology, as referenced in the ex-post sheet, appears to be consistent with the applied methodology and the applied tools. Since this parameter is critical for project emission calculations, maintaining transparency in data collection and conversion methods is essential.																	

Data/Parameter	n _{flare,m}						
Data unit	%						
Description	Flare efficiency in the minute						
Source of data	Plant records						
Value(s) applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024	
	Flare efficiency	90%	90%	90%	90%	90%	

VVB Opinion

The parameter $n_{\text{flare},m}$ represents the flare efficiency per minute, expressed as a percentage (%). The recorded data indicates a constant flare efficiency of 90% across all years, from 01-Jan-2020, to 31-Dec-2024. This value is sourced from plant records and is stated to be measured annually. Flare efficiency is a critical parameter in emission calculations, as it determines the effectiveness of methane combustion and influences the project's overall greenhouse gas (GHG) reduction claims.

The VVB notes that while the reported efficiency remains consistent across years, further clarification is needed on the measurement methodology. Given that flare efficiency can be affected by operational conditions, equipment maintenance, and external factors such as weather, an annual measurement may not fully capture variations.

Since this parameter directly affects emission reduction calculations, ensuring accurate and transparent reporting is critical.

Leakage Emissions

Ex-ante parameters:

Data/Parameter	Bo
Data unit	t CH ₄ /tCOD
Description	Maximum methane producing capacity
Source of data	TOOL14
Value(s) applied	0.25
VVB Opinion	The parameter Bo represents the maximum methane-producing capacity, expressed in tons of methane per ton of chemical oxygen demand (t CH ₄ /tCOD). The value applied for this parameter is 0.25, sourced from TOOL14 (presumably a recognized methodology or calculation tool for methane generation potential). This parameter is critical for estimating leakage emissions, as it defines the theoretical maximum methane yield from the organic matter present.

	The VVB acknowledges that TOOL14 is a recognized reference for determining methane-producing potential. The parameter is required for the calculations of the leakage emissions.
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Data/Parameter	MCF
Data unit	Dimensionless
Description	Methane conversion factor
Source of data	Table 6.3 of chapter 'Wastewater Treatment and Discharge' under the volume 'Waste' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	• 0.8 for a depth of liquid digestate storage ≥ 2 m; • 0.2 for a depth of liquid digestate storage < 2 m and ≥ 1 m; • 0 for a depth of liquid digestate storage < 1 m. 0.8 is applicable to project because the plant has > 3 m depth
VVB Opinion	The parameter MCF (Methane Conversion Factor) is a dimensionless factor used to estimate methane emissions from liquid digestate storage. It is sourced from Table 6.3, Chapter 'Wastewater Treatment and Discharge' in the volume 'Waste' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The applied values vary based on the depth of liquid digestate storage: • 0.8 for depths ≥ 2 m • 0.2 for depths ≥ 1 m and < 2 m • for depths < 1 m Since the project's liquid digestate storage depth exceeds 3 meters, the proponent has applied an MCF of 0.8. Additionally, while the IPCC provides a tiered approach to selecting MCF values, site-specific conditions such as temperature, retention time, and anaerobic conditions can influence methane production

	Since MCF is a key parameter in estimating leakage emissions, maintaining transparency in its selection is essential. The project proponent should ensure that any future changes to digestate storage conditions are recorded and reflected in emission calculations. Adherence to recognized guidelines strengthens the credibility of the reported emissions data.
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Data/Parameter	$F_{ww,CH_4,default}$
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
VVB Opinion	The parameter $F_{ww,CH_4,default}$ represents the default fraction of remaining methane production capacity in liquid digestate and is expressed as a fraction. This value is sourced from reference papers and current industry practices, with different default values assigned based on the type of anaerobic digestion system used: • 0.10 for covered anaerobic lagoons • 0.15 for UASB digesters, anaerobic filter bed digesters, and anaerobic fluidized bed digesters • 0.20 for conventional digesters • 0.05 for two-stage digesters For this project, $F_{ww,CH_4,default}$ value of 0.15 has been applied, based on the classification of the digestion system used. The validation team acknowledges that the selected value appears consistent with recognized industry benchmarks.

Since $F_{\text{ww,CH}_4,\text{default}}$ is a key parameter in estimating ex-ante leakage emissions, ensuring its accuracy is essential. If the system exhibits operational characteristics closer to another category (e.g., conventional digesters with higher methane residual potential), a different fraction may be more appropriate.

Monitored parameters:

Data/Parameter	$Q_{\text{stored},y}$					
Data unit	M^3					
Description	Amount of liquid digestate stored anaerobically in year y					
Source of data	Plant records					
Value(s) applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024
	Liquid digestate (m^3)	54,000	54,000	54,000	54,000	54,000
VVB Opinion	The parameter $Q_{\text{stored},y}$ represents the amount of liquid digestate stored anaerobically per year, expressed in cubic meters (m^3). The data is sourced from plant records and is measured annually. The recorded values indicate an initial volume of 54,000 m^3 for the period Jan 1, 2020, to December 31, 2020, followed by a consistent volume of 54,000 m^3 per year from 2020 to 2024.					
	The validation team acknowledges that the data is based on annual measurements, which provide a reasonable estimate of digestate storage trends.					
	The parameter $Q_{\text{stored},y}$ is used for calculating the leakage emissions.					

Data/Parameter	$P_{\text{COD},y}$
Data unit	tCOD/ m^3
Description	Average chemical oxygen demand (COD) of the liquid digestate in year y
Source of data	Plant records

Value(s) applied		01-01-2020 to 31-12-2020	01-01-2021 to 31-12-2021	01-01-2022 to 31-12-2022	01-01-2023 to 31-12-2023	01-01-2024 to 31-12-2024
	COD of liquid digestate(tCOD/m ³)	0.010	0.012	0.0115	0.016	0.0150
VVB Opinion	The parameter $P_{\text{COD},y}$ represents the average chemical oxygen demand (COD) of the liquid digestate per year, expressed in tCOD/m³. The data is sourced from plant records and is measured annually. The recorded values show fluctuations in COD concentrations over the years, with an initial value of 0.010 tCOD/m³ in 2020, and subsequent variations between 0.012 and 0.016 tCOD/m³ in later years. The latest value for 2024 stands at 0.015 tCOD/m³. The validation team notes that while annual measurements provide a useful estimate, the variations in COD values suggest possible changes in feedstock composition, digestion efficiency, or process conditions. The parameter is required for the calculation of the leakage emissions.					

Monitoring plan:

The plan employs a combination of automated and manual monitoring methods. Biogas flow and purified biogas generation are continuously recorded using automated systems, reducing the likelihood of errors. Waste input quantities are measured daily through a weighbridge and aggregated monthly for reporting purposes. These data are critical for calculating emission reductions and assessing the project's performance.

Data collection is complemented by a robust system for aggregation and archiving. At the end of each month or year, all monitored data is compiled into electronic files and securely stored. Supporting documents, such as maps, drawings, and applicable standards, are systematically archived to maintain an audit trail. This ensures that all relevant information is readily available for verification and auditing purposes.

Frequency of Monitoring:

The frequency of monitoring is well-defined in the plan. Biogas flow and purified biogas generation are monitored continuously, while waste input quantities are recorded daily. The frequency of data collection ensures that the monitoring system captures variations in project performance and provides a comprehensive dataset for emission reduction calculations. The periodic aggregation of data further supports the generation of accurate and transparent monitoring reports.

Monitoring Roles and Responsibilities:

The monitoring plan outlines clear roles and responsibilities for personnel involved in data collection and management. Plant monitoring staff are responsible for implementing data readings, periodic recordings, equipment maintenance, and calibration. They also handle necessary repairs and prepare monthly reports. These reports are submitted to the plant manager, who verifies their accuracy, checks for discrepancies such as typographical errors or unit mismatches, and ensures that corrective actions are taken if needed.

The plant manager also oversees the approval and submission of monitoring reports to relevant stakeholders. This hierarchical structure ensures accountability and reduces the likelihood of errors in data handling. All data and documents are systematically stored and made available to verifiers, enabling independent evaluation of data reliability and compliance.

Quality Assurance and Quality Control

The monitoring plan incorporates comprehensive quality assurance and quality control measures. All monitoring equipment is maintained and calibrated in accordance with manufacturers' instructions or national standards. Calibration schedules are strictly followed, and logs are maintained to document calibration activities, ensuring the accuracy and consistency of measurements.

Internal controls are in place to identify and address errors in data input, transformation, and output. The plan includes procedures for corrective actions, ensuring that any discrepancies are promptly resolved. These measures enhance the credibility of the data and the overall reliability of the monitoring system.

The monitoring plan is in compliance with the requirements of the selected methodology and Cercarbono's Protocol. It identifies relevant parameters, employs reliable monitoring methods, and ensures accurate and transparent data collection and reporting. The roles and responsibilities of monitoring staff are clearly defined, and the plan includes strong quality assurance and control measures to maintain data integrity.

The systematic approach to data collection, archiving, and reporting, combined with regular equipment calibration and maintenance, ensures that the monitoring system is capable of accurately quantifying greenhouse gas emission reductions. The plan adequately supports the project's objectives and aligns with international best practices, making it suitable for effective implementation and verification.

9.1 Responsible for CCMP monitoring

The monitoring plan outlines clear roles and responsibilities for personnel involved in data collection and management. Plant monitoring staff are responsible for implementing data readings, periodic recordings, equipment maintenance, and calibration. They also handle necessary repairs and prepare monthly reports. These reports are submitted to the plant manager, who verifies their accuracy, checks for discrepancies such as typographical errors or unit mismatches, and ensures that corrective actions are taken if needed.

The plant manager also oversees the approval and submission of monitoring reports to relevant stakeholders. This hierarchical structure ensures accountability and reduces the likelihood of errors in data handling. All data and documents are systematically stored and made available to verifiers, enabling independent evaluation of data reliability and compliance.

9.2 CCMP monitoring development

The data and the parameters that are fixed and monitored are provided in detail in section 9 of this report.

Roles and Responsibilities:

The project owner is responsible for overall data reliability, calibration, and report generation. The monitoring staff is tasked with data collection, maintenance of equipment, and periodic reporting. The plant manager reviews monitoring reports, verifies recorded data, and ensures error correction. This structured hierarchy ensures proper accountability and systematic verification of data.

Adequate Data Management and Quality Control:

Continuous recording of key parameters such as biogas generation, incinerated waste, and fuel usage. Internal checks and data validation are performed regularly to identify and correct errors, such as unit mismatches or calculation inconsistencies. Calibration of monitoring equipment (gas flow meters, weighbridges, etc.) is conducted per manufacturer and national standards, ensuring measurement accuracy. Data archiving and retention for at least two years post-crediting period, allowing for independent verification.

Conclusion:

The monitoring system follows the requirements outlined in the selected methodology and Cercarbono's Protocol, ensuring structured data collection, processing, and reporting for greenhouse gas (GHG) emissions quantification. The methodology integrates primary data collection, secondary data sources, and established monitoring guidelines (e.g., IPCC, TOOL08, TOOL14), demonstrating a commitment to transparency and accountability in emission calculations.

The monitored parameters are well-defined, covering key elements such as waste quantities, methane generation, fuel combustion, and flare efficiency, which are essential for estimating project emissions and leakage emissions. The use of continuous and periodic monitoring, along with estimations where necessary, provides a structured approach to data collection and reporting.

10 Information management

The procedures outlined for data and information quality and management are designed to ensure the reliability, accuracy, and transparency of the data collected for greenhouse gas (GHG) quantification. Below is a detailed assessment of the processes, including an evaluation of uncertainty management:

Data Aggregation, Storage, and Availability:

The monitoring plan specifies that all data relevant to GHG quantification will be aggregated, summarized, calculated, and recorded as electronic files monthly or yearly, as appropriate. Supporting documents, such as maps, drawings, standards, and monitoring guidance, are systematically stored. This approach ensures a comprehensive audit trail that enables the verification of data integrity and reliability.

By maintaining detailed records and keeping all relevant documents until two years after the end of the crediting period, the project adheres to best practices in data management. This ensures that verifiers have access to all necessary information to evaluate compliance with methodology requirements.

Quality Assurance and Quality Control (QA/QC):

The QA/QC framework focuses on maintaining the accuracy and reliability of monitoring equipment and data. The procedures include the following key elements:

- **Calibration of Equipment:** All monitoring equipment, such as gas flow meters and weighbridges, is calibrated according to manufacturers' instructions or national standards. This ensures that measurements are accurate and consistent over time.
- **Scheduled Maintenance:** Regular maintenance of equipment prevents technical malfunctions, reducing the likelihood of errors in data collection. Logs documenting calibration and maintenance activities are maintained as part of the QA/QC system.
- **Error Identification and Correction:** Internal controls, such as checks for typographical errors, unit mismatches, and discrepancies in recorded data, are implemented. Identified errors are promptly corrected to ensure data reliability.
- **Compliance with Standards:** Calibration and maintenance schedules are aligned with nationally prescribed standards, enhancing the credibility of the monitoring system.

These measures collectively provide a robust framework for maintaining data quality, minimizing the risk of inaccuracies, and ensuring that the monitoring system meets the required standards.

Data Access and Transparency:

The plan ensures that all collected data and relevant documents are systematically stored and made accessible to verifiers. This promotes transparency and allows for independent verification of the monitoring results. The availability of supporting documentation, such as calibration records and monitoring guidance, enables verifiers to evaluate the appropriateness of data management practices.

Uncertainty Assessment:

The following elements address potential sources of uncertainty in data collection and management:

- **Calibration Accuracy:** Regular calibration of monitoring equipment minimizes measurement errors, a key source of uncertainty.
- **Systematic Data Recording:** Daily or continuous monitoring reduces the risk of gaps or inconsistencies in the dataset.
- **Internal Controls:** Cross-checking and reviewing recorded data help to identify and rectify errors, further reducing uncertainty.
- **Implementing these measures** ensures that uncertainties associated with data collection, measurement, and reporting are minimized, enhancing the overall reliability of the monitoring system.

The procedures for data and information quality and management, including QA/QC measures and uncertainty assessment, are comprehensive and aligned with monitoring methodology. The emphasis on equipment calibration, systematic data storage, error correction, and transparency ensures that the data collected for GHG quantification is reliable, accurate, and verifiable. The plan provides a solid framework for maintaining data integrity and minimizing uncertainties, supporting the credibility of the emission reduction claims.

11 Assessment of CCMP status

During the monitoring period, no changes in risks or material discrepancy thresholds were observed that could have impacted the validation and verification process. The analysis procedures applied remained consistent, representative, and appropriate throughout.

The evidence gathered during the process was both sufficient and reliable, enabling a well-founded and conclusive determination.

12 Validation and verification conclusion

12.1 Resolution of findings

The joint validation and verification report was prepared once the VVB declared the findings identified during the document review stage, the remote audit and the interviews resolved.

The VVB has raised 1 CL and 7 CARs.

To guarantee the transparency of the validation and verification process, the requests required by the validation team and the response provided by the PP are described below:

CL ID	01	Date: 30/01/2025
Description of CL		
During the onsite inspection, interview with the plant head and review of the plant's operational logbook, it was confirmed that the plant's runtime for the year 2024 is 7400 hours, which equals to 308 working days. However, Section 1.7 of the PDD states a runtime of 7200 hours, PP to clarify the difference in the working hours mentioned.		
PP Response		Date: 20/02/2025
<i>We have updated this inconsistency in 1.7 of the PDD.</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025
The PP has provided a revised version of the PDD dated 20/02/2025, where the inconsistency in Section 1.7 regarding the plant's runtime has been corrected. The updated PDD now reflects the actual runtime of 7400 hours (308 working days) for the year 2024, which aligns with the information obtained during the onsite inspection, interviews with the plant head, and the operational logbook review. The VVB has reviewed the revised PDD and confirms that the correction has been appropriately implemented. Hence, CL01 is closed.		

Table 2. CARs from this joint validation and verification

CAR ID	01	Date: 30/01/2025
Description of CAR		
The CCMP incinerates approximately 640 tons of waste daily, covering 70% of waste transported to the final disposal complex, while the remaining waste is landfilled. Using advanced incineration technology, the plant converts waste into thermal energy and the thermal energy is used to generate electricity with the help of steam turbines. The CCMP uses 17 percent of the electricity generated as auxiliary with excess power supplied to the national grid. The facility incorporates systems to manage emissions, including activated carbon, sodium bicarbonate, hydrated lime, and bag filters, minimizing pollutants like dioxins and heavy metals. Leachate generated from waste is collected, treated, and discharged to the nearby river after meeting local effluent standards. Byproducts such as slag and fly ash are dumped at the landfill. During the onsite inspection and the interview with the plant head, it was confirmed that the fly ash and the slag generated by the CCMP are being dumped in the nearby landfill site. However, Section 1.4 of the PDD states that the fly ash is buried underground. PP to revise the CCMP description in the PDD to accurately reflect the actual CCMP scenario.		
PP Response		Date: 20/02/2025
<i>We have updated this inconsistency in 1.4 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025
The PP has submitted an updated version of the PDD dated 20/02/2025, where the description in Section 1.4 has been revised to accurately reflect the actual handling of fly ash and slag at the CCMP facility. The revised PDD now correctly states that fly ash and slag are dumped in the nearby landfill site, aligning with the findings from the onsite inspection and the interview with the plant head. The VVB has reviewed the updated PDD and confirms that the necessary correction has been implemented appropriately. Hence, CAR01 is closed.		

CAR ID	02	Date: 30/01/2025
Description of CAR		
PP to assess the applicability conditions of the tools applicable to the CCMP in section 2.1 of the PDD.		
PP Response		Date: 20/02/2025
<i>We have updated the applicability conditions of the tool in section 2.1 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025
The PP has submitted an updated version of the PDD dated 20/02/2025, where Section 2.1 has been revised to include the assessment of the applicability conditions of the tools used in the CCMP. The VVB has reviewed the updated section and confirms that the applicability conditions have been clearly defined and align with the requirements of the selected methodology and tools. The revision ensures that the project correctly applies the tools, demonstrating compliance with the necessary eligibility and methodological conditions. Hence, CAR02 is closed.		

CAR ID	03	Date: 30/01/2025
Description of CAR		
During the onsite inspection and the interview with the plant head, it was confirmed that the capacity of the waste bunker is 1,280 tonnes per day, and only 1,280 tonnes per day will be processed by the plant. However, Section 1.7 of the PDD states that the daily processing capacity of the project is 1,400 tonnes. PP to mention the actual capacity of the plant.		
PP Response		Date: 20/02/2025

<i>We have updated this inconsistency in the Section 1.7 of the PDD and the plant capacity is 1,280 tonnes per day</i>	
Documentation provided by PP	
<i>PDD dated 20/02/2025</i>	
VVB assessment	Date: 25/02/2025
The PP has submitted an updated version of the PDD dated 20/02/2025, in which Section 1.7 has been revised to accurately reflect the actual daily processing capacity of 1,280 tonnes per day instead of 1,400 tonnes per day. Upon review, the VVB confirms that the updated PDD now correctly represents the plant's operational capacity as verified during the onsite inspection and interview with the plant head. The revision aligns with the actual project implementation, ensuring consistency in project documentation. Hence, CAR03 is closed.	

CAR ID	04	Date: 30/01/2025
Description of CAR		
PP to mention the following in section 1.7 of the PDD: 1. The Lifetime of the Generator.		
PP Response		Date: 20/02/2025
<i>We have updated the information in the section 1.7 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025. https://www.gevernova.com/gas-power/services/steam-turbines/upgrades</i>		
VVB assessment		Date: 25/02/2025

The PP has provided the necessary updates in section 1.7 of the Project Design Document (PDD) regarding the lifetime of the generator. The revised PDD, dated 20/02/2025, has been reviewed. The information now aligns with the project requirements and ensures clarity on the generator's operational lifespan.

The provided reference link (<https://www.gevernova.com/gas-power/services/steam-turbines/upgrades>) has been reviewed for relevance and supports the stated lifetime considerations. Hence, CAR04 is closed.

CAR ID	05	Date: 30/01/2025
Description of CAR		
PP to demonstrate the Chronological plan in section 1.8 of the PDD, including: 1. The accreditation period of the CCMP. 2. The frequency of CCMP monitoring and reporting, including relevant CCMP activities at each step of the project cycle. 3. The frequency of the verification events, including the periods in which verification events are intended or performed.		
PP Response		Date: 20/02/2025
<i>We have updated this information in the section 1.8 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025

The project participant (PP) has provided updates in section 1.8 of the Project Design Document (PDD). The review of the updated PDD, dated 20/02/2025, confirms that the following required details have been incorporated:

1. Accreditation period of the CCMP – Clearly defined and aligned with applicable standards.
2. Frequency of CCMP monitoring and reporting – Adequately detailed, including relevant activities at each step of the project cycle.
3. Frequency of verification events – Specified along with intended or performed verification periods.

Hence, CAR05 is closed.

CAR ID	06	Date: 30/01/2025
Description of CAR		
PP to clearly segregate the parameters into two categories in Sections 10.2 and 10.3 of the PDD: 1. Data and parameters fixed ex-ante. 2. Data and parameters to be monitored. This segregation should be done separately for both baseline emissions and project emissions to ensure the alignment with the monitoring methodology.		
PP Response		Date: 20/02/2025
<i>We have updated this inconsistency in the section 10.2 and 10.3 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025
The project participant (PP) has updated sections 10.2 and 10.3 of the Project Design Document (PDD) to clearly segregate the parameters into two categories: 1. Data and parameters fixed ex-ante. 2. Data and parameters to be monitored. The segregation has been done separately for both baseline emissions and project emissions, ensuring alignment with the monitoring methodology. Hence, CAR06 is closed.		

CAR ID	07	Date: 30/01/2025
Description of CAR		
PP to mention and monitor: 1. All the applicable parameters in the baseline scenario in section 10.2 of the PDD. 2. All the applicable parameters in the project scenario in section 10.3 of the PDD.		
PP Response		Date: 20/02/2025
<i>We have updated this information in the section 10.2 and 10.3 of the PDD</i>		
Documentation provided by PP		
<i>PDD dated 20/02/2025</i>		
VVB assessment		Date: 25/02/2025
The PP has updated sections 10.2 and 10.3 of the Project Design Document (PDD) to include and monitor all applicable parameters in both the baseline and project scenarios. Hence, CAR07 is closed.		

12.2 Support and listing of information

The information provided by the PP and the commercial and technical information that is generated by EPIC as a part of the validation and verification process, such as:

- Terms of engagement.
- Validation / Verification plan.
- Evidence collection plan.
- Requests for clarification, misstatements and non-conformities arising from the validation and the conclusion reached.

- Communication with the client regarding material misstatements.
- The conclusions reached and the opinions of the validator/verifier.

All the above informations are stored in the EPIC server, which keeps the information in a reliable, secure and traceable manner.

12.3 Validation and verification opinion

Kanaka Management Services Private Limited contracted EPIC Sustainability Services Private Limited to undertake joint validation and verification of the project activity titled **“Avoidance of methane emission from Municipal Solid Waste project in Ethiopia”** with ID 238. The review of the PDD v2.0^{/7/} and the MR v2.0^{/8/} and the onsite audit with subsequent interviews provided EPIC with sufficient evidence to determine compliance with the validation and verification criteria.

The CCMP proposed by the PP correctly applies the methodology:

CDM approved large-scale methodology issued by the CDM Executive Board, ACM0022: “Alternative waste treatment process version 3.0”^{/4/}.

EPIC declares that the project is validated and verified based on the following key parameters:

- Reasonable Assurance: The verification process achieved a confidence level of 95%, ensuring the credibility and reliability of findings.
- Materiality Threshold: A materiality level of 5% was adhered to, aligning with the applicable standards.
- GHG Declaration: The greenhouse gas (GHG) declaration was assessed to be materially accurate, fairly represented, and prepared in compliance with the relevant standards.
- Monitoring Plan: The monitoring plan was evaluated as transparent, comprehensive, and adequate for the intended purpose.

Furthermore, EPIC confirms that the emission reductions achieved under the CCMP were calculated transparently and conservatively, adhering to the methodology and monitoring plan specified in the PDD and documented in the MR.

Validated Estimated Emission reductions for the 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	1,28,239	55,686	4,661	67,891
Year 3	1,59,208	55,686	4,661	98,860
Year 4	1,85,789	55,686	4,661	1,25,442
Year 5	2,08,668	55,686	4,661	1,48,321
Year 6	2,28,418	55,686	4,661	1,68,070
Year 7	2,45,519	55,686	4,661	1,85,171
Year 8	2,60,372	55,686	4,661	2,00,025
Year 9	2,73,318	55,686	4,661	2,12,970
Year 10	2,84,638	55,686	4,661	2,24,290
Total	20,66,235	5,56,864	46,613	14,62,757
Average	2,06,624	55,686	4,661	1,32,978

Verification Emission Reductions for the period: From 01/01/2020 to 31/12/2024

Monitoring pe- riod	Baseline sce- nario(tCO ₂ e)	Project scenario(tCO ₂ e)		Net reduc- tion(tCO ₂ e)
	GHG emissions	GHG emissions	Leakage	
01/01/2020 to 31/12/2020	89,882	54,796	3,208	31,878
01/01/2021 to 31/12/2021	75,047	19,662	3,499	51,886
01/01/2022 to 31/12/2022	61,779	8,618	3,353	49,808
01/01/2023 to 31/12/2023	1,08,099	8,851	4,666	94,582
01/01/2024 to 31/12/2024	1,32,115	9,075	4,374	1,18,666
Total	4,66,922	1,01,002	19,100	3,46,820

12.4 Findings after validation and verification

This section is not applicable.

13 References

Sl. No	Author	Title of the Document	Provided by
1	CerCarbono	Cercarbono's Protocol for Voluntary Carbon Certification versión 4.4	Publicly available
2	CerCarbono	Procedures of Cercarbono's Certification Programme versión 2.2	Publicly available
3	CerCarbono	Terms and Definitions of the Voluntary Certification Programme of Cercarbono versión 3.1	Publicly available
4	UNFCCC	Large-scale Consolidated Methodology: Alternative waste treatment processes version 3.0	Publicly available
5	UNFCCC	Combined tool to identify the baseline scenario and demonstrate additionality versión 7.0	Publicly available
6	UNFCCC	(a) TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion versión 3.0 (b) TOOL04 : Emissions from solid waste disposal site, versión 8.1 (c) TOOL06: Project emissions from flaring, versión 4.0 (d) TOOL14: Project and leakage emissions from anaerobic digesters, versión 3.0 (e) TOOL23: Additionality of first-of-its-kind project activities	Publicly available
7	PP	PDD v1.0 PDD v2.0	PP
8	PP	MR v1.0 MR v3.0	PP
9	EEP	Commissioning Certificate	PP
10	China National Electric Engineering Co., Ltd (CNEEC) and Cambridge Industries	Technical specifications of the facilities in the project	PP

	Limited (CIL)		
11	PP	Plant Records for the Monitored parameters	PP
12	IPCC	IPCC 2006 Guidelines for National Greenhouse Gas Inventories	Publicly available
13	Japan International Co-operation Agency (JICA)	Project Completion Report	PP

14 Appendix 1 : Pictures of onsite inspection







15 Document history (Joint Validation and Verification Report)

Version	Date	Comments or editions
1.0	16/04/2025	Initial version.

16 Template history

Version	Date	Comments or editions
1.0	30.10.2019	Initial version.
2.0	01.08.2022	New template for the joint validation and verification process that applies to CCMPs in sectors other than land use.

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