METHODOLOGICAL DOCUMENT
AFOLU SECTOR
LIVESTOCK & MANURE MANAGEMENT

BCR0008. Biomethanisation Plants Animal Manure Management for Renewable Energy, Heat Generation, and CH_4 & N_2O Mitigation

BIOCARBON CERT®

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1 Introduction

This methodological document establishes the requirements for the identification of the baseline scenario, demonstration of additionality, quantification of greenhouse gas (GHG) emission reductions, monitoring, leakage management, and uncertainty treatment for biomethanisation activities under the BioCarbon Standard.

The methodology applies to centralized manure treatment systems that collect animal manure from livestock operations and process it through anaerobic digestion or related Animal Waste Management Systems (AWMSs). Manure may be transported via tank trucks, pipelines, or pumping systems to a central treatment facility.

The project activity consists of replacing or modifying existing anaerobic manure management practices at farm level with controlled treatment systems designed to capture and manage methane for flaring, combustion, or energy generation.

Eligible livestock categories include, but are not limited to, dairy and beef cattle, buffalo, swine, sheep, goats, poultry, and other confined animal production systems.

The mitigation outcome under this methodology results from the avoidance of methane (CH_4) emissions and, where applicable, nitrous oxide (N_2O) emissions that would otherwise occur under baseline manure management conditions.

To ensure environmental integrity, the methodology establishes a quantitative cap whereby credited methane avoidance shall not exceed the volume of methane demonstrably captured, combusted, or otherwise effectively managed under the project activity.

2 Objectives

The objectives of this Methodology are to:

(a) establish the criteria and procedures for the identification of a credible, conservative, and plausible baseline scenario for centralized biomethanisation activities involving animal manure;

(b) define the requirements for demonstrating additionality in accordance with the BioCarbon Additionality Tool;

(c) set out the methodological procedures for the quantification of methane (CH_4) and nitrous oxide (N_2O) emission reductions resulting from the replacement or modification of anaerobic manure management systems at livestock operations;

(d) define the requirements for the quantification of project emissions, baseline emissions, and leakage emissions associated with centralized treatment systems, including the use of biogas for flaring, combustion, or energy generation;

(e) establish monitoring, reporting, and verification (MRV) requirements for all parameters relevant to the calculation of emission reductions;

(f) define procedures for uncertainty assessment and conservative adjustment in accordance with the BioCarbon Uncertainty Management Tool;

(g) ensure that baseline emissions remain representative of Business-as-Usual (BAU) conditions and are reassessed where material regulatory or structural changes occur;

(h) require demonstration of alignment with the host country's Nationally Determined Contribution (NDC) and compliance with the BioCarbon Avoiding Double Counting (ADC) Tool, where applicable.

3 Version and validity

This version constitutes the Version 2.0 for public consultation. February 19, 2026.

This version may be updated from time to time and intended users shall ensure that they use the most recent version of the document.

4 Scope

This methodology provides the requirements for the establishment of the baseline scenario, demonstration of additionality, quantification of greenhouse gas (GHG) emission reductions, monitoring, leakage management, and uncertainty treatment for centralized biomethanisation activities under the BioCarbon Standard.

The methodology applies to activities that collect animal manure from one or more livestock operations and process it at a centralized treatment facility through anaerobic digestion or related Animal Waste Management Systems (AWMSs), with the objective of capturing and managing methane for flaring, combustion, or energy generation.

The mitigation outcome under this methodology results exclusively from the avoidance of methane (CH_4) emissions and, where applicable, nitrous oxide (N_2O) emissions that would otherwise occur under baseline manure management practices.

This methodology does not account for carbon removals, carbon sequestration, or long-term carbon storage. Emission reductions are generated solely through the displacement or prevention of methane and nitrous oxide emissions relative to baseline conditions.

This methodology shall be used exclusively by project holders seeking certification and registration under the BioCarbon Standard.

5 Applicability conditions

This Methodology is applicable under the following conditions:

(i) Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, are managed under confined conditions;

(j) Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries);

(k) Farms where animal residues are treated under anaerobic conditions;

(l) The annual average temperature in the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C;[1]

(m) In the cases where the baseline anaerobic treatment system is an open lagoon, the lagoon depth shall be greater than 1 m;[2]

(n) The retention time of the organic matter in the baseline anaerobic treatment systems shall be at least 30 days;

(o) If residues are stored in between collection activities, storage tanks shall comprise outdoor open equipment;

(p) If the treated residue is used as fertilizer in the baseline, project holders must ensure that this end use remains the same throughout the project activity;

(q) Sludge produced during the project activity shall be stabilized through thermal drying or composting, prior to its final disposition/application;

[1] If monthly average temperature in a particular month is less than 5°C, this month is not included in the estimations, as it is assumed that no anaerobic activity occurs below such temperature.

[2] In particular, loading in the wastewater streams has to be high enough to assure that the lagoon develops an anaerobic bottom layer and that algal oxygen production can be ruled out.

(r) The AWMS/process in the project case shall ensure that no leakage of manure waste into ground water takes place, e.g., the lagoon shall have a non-permeable layer at the lagoon bottom;

(s) Technical measures shall be used (including a flare for exigencies) to ensure that all biogas produced by the digester is used or flared;

(t) The storage time of the manure after removal from the animal barns, including transportation, shall not exceed 45 days before being fed into the anaerobic digester. If the project holder can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.

(u) In the case that the project involves co-digestion of organic waste, emission reductions related to the organic waste portion of feed material shall be accounted as baseline leakage emission following the related procedures described in the leakage section of this methodology. VCCs resulting from these emissions shall not be claimed.

(v) Projects that recover methane from landfills shall use "AMS-III.G Landfill methane recovery" and/or "ACM0001: Flaring or use of landfill gas" and projects for wastewater treatment shall use "AMS-III.H Methane recovery in wastewater treatment" and/or "ACM0014 Treatment of wastewater".

VCCs shall be claimed by the Central Treatment Plant managing person/entity, only. Other parties involved must sign a legally binding declaration that they will not claim VCCs from the improved animal waste treatment practices. Such declarations shall be verified by the CAB during the validation, and these documents shall be valid throughout the whole crediting period.

In addition, the applicability conditions included in the tools referred to below apply.

This methodology is only applicable if the application of the procedure to identify the baseline scenario results in that anaerobic manure treatment systems without methane recovery in the farms are the most plausible baseline scenario.

5.1 Applicability of sectoral scopes

Conformity Assessment Bodies (CABs) are required to apply sectoral scopes 13 and 15 when validating and verifying project's activities using this methodology.

6 Methodological basis and technical references

This methodology has been developed building upon internationally recognized methodologies and technical tools for manure management and anaerobic digestion projects.

In particular, the calculation structure, parameter definitions, and emission estimation approaches are informed by:

(a) AM0073: GHG emission reductions through multi-site manure collection and treatment in a central plant;
(b) ACM0010: Consolidated baseline methodology for GHG emission reductions from manure management systems;
(c) AMS-III.D: Methane recovery in animal manure management systems;
(d) AMS-III.AO: Methane recovery through controlled anaerobic digestion;
(e) CDM Tool 14: Project and Leakage Emissions from Anaerobic Digesters;
(f) CDM Tool 03, Tool 04, Tool 05, Tool 07, and other relevant technical tools where applicable;
(g) IPCC 2006 Guidelines and 2019 Refinement.

These references are used as technical foundations for calculation structure and emission factor selection.

These tools are referenced for calculation structure only and do not constitute normative instruments under the BioCarbon Standard.

Normative determination of baseline, additionality, leakage, uncertainty management, monitoring, and credit issuance shall be governed exclusively by the BioCarbon Standard and its associated tools.

7 Normative References

The following documents are normative and indispensable for the application of this methodology. For dated references, only the cited edition applies. For undated references, the latest version in force at the time of validation or verification shall apply.

7.1 BioCarbon Program instruments (Primary Normative Framework)

The following references are indispensable for the application of this Methodology:

(a) BCR Standard, latest version in force;

(b) BioCarbon Additionality Tool v1.0 (Identification of Baseline Scenario and Demonstration of Additionality);
(c) BioCarbon Uncertainty Management Tool v1.0;
(d) BioCarbon Monitoring, Reporting and Verification (MRV) Tool v2.0;
(e) BioCarbon Avoiding Double Counting (ADC) Tool, latest version;
(f) BioCarbon Standard Operating Procedures (SOP), where applicable.

7.2 International accounting and scientific standards

(a) IPCC 2006 Guidelines for National Greenhouse Gas Inventories;
(b) 2019 Refinement to the 2006 IPCC Guidelines;
(c) ISO 14064-2:2019 – Project-level GHG quantification;
(d) ISO 14064-3:2019 – Validation and verification;

7.3 Applicable national legislation

Applicable national legislation governing GHG projects and environmental compliance in the host country.

8 Terms and definitions

Additionality

Is the effect of the GHG Project activity to reduce anthropogenic GHG emissions below the level that would have occurred in the absence of the GHG Project activity.

Agriculture, Forestry, and Other Land Use (AFOLU)

Sector comprising greenhouse gas emissions and/or removals attributable to project activities in the agriculture, forestry and other land use sector.

Baseline scenario

The scenario for the GHG project that reasonably represents the sum of carbon stock changes within the project boundary that would occur in the absence of the GHG project[3].

Project start date

Date on which activities that will result in actual GHG emission reductions begin. For GHG projects applying this methodology, the start date corresponds to the date on which the implementation of project activities begins.

[3] Adapted of Glossary CDM terms. Version 10.0

Permanence

Permanence refers to the risk of reversal of carbon removals or stored carbon stocks over time.

This methodology generates emission reductions through methane and nitrous oxide avoidance and does not involve carbon sequestration or long-term carbon storage. Therefore, permanence risk associated with carbon stock reversal does not apply to activities under this methodology.

GHG Project (Greenhouse gases project)

Activity or activities that change the conditions of a GHG baseline and cause GHG emissions to be reduced or GHG removals to be increased[4].

For activities applying this methodology, mitigation outcomes are achieved through emission reductions only.

Flaring

Combustion of biogas at an enclosed / open flare;

Venting

Engineered or intentional releases of gases into the atmosphere, such as the venting of biogas from anaerobic digesters;

Co-digestion

Co-digestion is the simultaneous digestion of a homogenous mixture of two or more substrates from different sources, e.g. co-digestion of animal manure and MSW (municipal solid waste). The most common situation is when a major amount of a primary basic substrate (e.g. manure) is mixed and digested together with minor amounts of other substrates;

Effluent

Untreated effluent of the anaerobic digester;

Treated effluent

Effluent of the anaerobic digester that is stabilized through thermal drying treatment;

4 ISO 14064-3:2019(es), 3.4.1.

Residue

Effluent of the anaerobic digester that is stabilized through the composting process.

The definitions provided in the normative references given above, along with the Glossary of CDM Terms, shall be applicable. In case of any discrepancies in the definitions across the various normative references cited above, the definition from the latest normative reference shall be adopted.

9 Project boundaries

The spatial extent of the project boundary encompasses:

(a) The central treatment plant;

(b) The livestock farms[5];

(c) The site of the biogas combustion or energy generation facility (if existent);

(d) The manure storage tanks;

(e) The road itineraries and/or piping system between the feedstock collection points and the central treatment plant;

(f) The road itineraries between the central treatment plant where treated effluent is generated and the agricultural plots where it is applied.

9.1 Project temporal boundaries and analysis period

Project temporal boundaries correspond to the periods during which project activities are carried out and GHG emission reductions are quantified.

The project temporal boundaries shall be defined considering the following:

(a) The start date of the project;

(b) The period of quantification of the reductions; and

(c) The monitoring periods.

[5] Any changes to animal manure supplier farms, including the addition of new suppliers or the removal of existing ones, must be thoroughly justified and documented in the Project Document. The Designated Operational Entity (CAB) is responsible for assessing and validating whether the new animal manure supplier farms meet the baseline scenario's applicability conditions.

Project emission reductions are accounted for during the project's quantification period. That is, the period during which the project holder quantifies GHG reductions, measured against the baseline, for the purpose of request the issuance of Verified Carbon Credits (VCCs).

The analysis period for the project area during verification corresponds to the monitoring period.

9.2 Carbon reservoirs

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1. Emissions sources included in or excluded from the project boundary

Source		Gas	Included / Excluded	Justification / Explanation
Baseline	Direct emissions from the manure treatment processes	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Included	The major source of emissions in the baseline scenario
		N_2O	Included	Important source of emissions in the baseline scenario
	Emissions from electricity consumption / generation	CO_2	Included	Electricity may be consumed from the grid or generated onsite in the baseline scenario
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Emissions from thermal	CO_2	Included	If thermal energy generation is included in the project activity
		CH_4	Excluded	Excluded for simplification. This is conservative.

Source		Gas	Included / Excluded	Justification / Explanation
	energy generation	N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	Emissions from thermal energy generation	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Included	May be an important emission source. If electricity is generated from collected biogas, these emissions are not accounted for.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Direct emissions from the manure treatment processes	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	The emission from uncombusted methane, physical leakage, and minor CH_4 emissions from aerobic treatment.
		N_2O	Included	May be an important emission source.
	Emissions from animal manure (and treated	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.

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Source		Gas	Included / Excluded	Justification / Explanation
	effluent) transportation	N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from sludge composting	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	May be an important emission source.
		N_2O	Included	May be an important emission source.
	Emissions from manure storage tanks	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	May be an important emission source.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

The project holders shall furnish the project document with a detailed diagrammatic representation of the project scenario, including all pre-treatment and treatment steps involved in managing manure waste, as well as its final disposal. This diagram shall also highlight the fraction of volatile solids that degrade within the project's boundaries before disposal, as observed in the situation before the project's initiation. Furthermore, it needs to document the ultimate handling of any methane captured and the auxiliary energy required for the operation of project treatment steps, including pre-treatment processes.

The project holder shall clearly identify in the project document the precise locations of each farm supplying animal manure for the project activity. This includes the names of the farms, their distances in kilometers to the central treatment plant, the type of livestock they house, and their coordinates (e.g., using the Global Positioning System). This detailed information ensures transparency and traceability of the project's input sources.

10 Baseline and additionality

10.1 General principles

The project activity shall establish a credible, conservative, and realistic baseline scenario representing the most plausible management practice that would occur in the absence of the project activity.

The baseline scenario shall:

(a) Reflect actual prevailing manure management practices within the applicable geographic area;
(b) Be technically feasible, legally permitted, and economically accessible;
(c) Not assume hypothetical improvements beyond existing practice;
(d) Be consistent with national livestock production systems and manure handling conditions;
(e) Avoid any overestimation of methane emissions in the baseline.

The baseline and additionality assessment shall be conducted in accordance with the BioCarbon Additionality Tool v1.0, which is mandatory for all project activities under the BioCarbon Standard.

Internal methodological procedures shall not substitute the application of the BioCarbon Additionality Tool.

10.2 Ensuring baseline emissions are conservatively defined relative to Business-as-Usual (BAU)

The baseline scenario identified under this methodology shall represent the most plausible management practice that would occur in the absence of the project activity and shall not be set above Business-as-Usual (BAU) conditions.

For the purposes of this methodology, BAU refers to:

(a) Existing manure management systems commonly applied in the relevant geographic area;
(b) Practices consistent with mandatory regulatory requirements;
(c) Management systems that reflect prevailing technological, economic, and policy circumstances.

The baseline scenario shall not assume:

(a) Outdated practices that are no longer commonly implemented in the region;

(b) Management systems that are inconsistent with binding regulatory requirements;
(c) Artificially inflated methane conversion factors or emission parameters beyond those supported by IPCC guidance or nationally recognized data.

Where multiple plausible baseline scenarios exist, the scenario resulting in the lowest credible baseline emissions shall be selected, unless a higher-emitting alternative can be objectively demonstrated to be more plausible based on transparent economic and regulatory analysis in accordance with the BioCarbon Additionality Tool.

For greenfield facilities, the selection of uncovered anaerobic lagoons as baseline shall be justified through documented economic and regulatory analysis demonstrating that such systems represent the most plausible course of action under prevailing conditions.

In no case shall the baseline scenario result in emission levels demonstrably higher than those of comparable existing facilities operating under similar technical and regulatory conditions.

Baseline assumptions shall be transparently documented and subject to independent validation and verification.

10.3 Identification of alternative scenarios

The project holder shall identify all realistic and credible alternative scenarios to the proposed biomethanisation project activity, including at minimum:

(a) Continuation of current manure management practices (e.g., anaerobic lagoons, open storage, unmanaged decomposition);
(b) Alternative manure treatment options commonly applied in the region (e.g., composting, direct land application without digestion);
(c) Implementation of anaerobic digestion without carbon crediting;
(d) Alternative waste management solutions adopted by comparable livestock operations in the applicable geographic area.

Alternative scenarios shall be:

(a) Technically feasible;

(b) Consistent with mandatory laws and regulations;

(c) Financially and operationally plausible.

Scenarios that are legally required and effectively enforced shall not be considered valid baseline alternatives.

10.4 Selection of the baseline scenario

The baseline scenario shall correspond to the most plausible alternative scenario identified under Section 10.2, consistent with the outcome of the BioCarbon Additionality Tool.

For biomethanisation projects, the baseline shall typically correspond to:

(a) Anaerobic decomposition of manure under uncontrolled conditions without methane capture;
(b) Storage in lagoons or pits with methane emissions released to the atmosphere;
(c) Other manure management systems with equivalent methane release characteristics.

Baseline methane emissions shall be quantified in accordance with:

(a) IPCC 2006 Guidelines, Volume 4, Chapter 10 (Manure Management);
(b) Relevant CDM methodological tools (where applicable for calculation structure only, not for additionality determination);
(c) Conservative parameter selection consistent with national inventory data, where available.

Where more than one alternative is considered equally plausible, the most conservative emission outcome shall be selected.

Where national emission factors exist, these shall be used in preference to default factors, provided they are transparent and officially recognized.

10.5 Identification of the Baseline Scenario for Manure Management

10.5.1 For existing facilities

In applying Step 1 of the BioCarbon Additionality Tool, baseline alternatives for managing the manure, shall take into consideration, inter alia, the complete set of existing/possible manure management systems listed in the 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10, Table 10.17-updated). In drawing up a list of possible scenarios, possible combinations of AWMS shall be considered.

10.5.2 For greenfield facilities

For Greenfield facilities, the methodology only applies where the baseline scenario selected from the complete set of the list of the 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10, Table 10.17-updated), is an uncovered anaerobic lagoon.

The following two steps will define the baseline uncovered anaerobic lagoon:

(a) Define several anaerobic lagoon design options for the particular manure stream that meet the relevant regulations and take into consideration local conditions (e.g. environmental legislation, ground water table, land requirement, temperature). Design specifications shall include average depth and surface area of the anaerobic lagoon, residence time of the organic matter, as well as any other key parameters. Document the different design options in a transparent manner and provide transparent and documented evidence of key assumptions and data used, and offer conservative interpretations of this evidence;

(b) Carry out an economic assessment of the identified lagoon design option, as per Step 3 (investment analysis) of the latest approved version of the BioCarbon Additionality Tool, and additional guidance given below. Choose the least cost lagoon design option that remains technically and legally feasible under prevailing conditions, identified through Step (a) above. If several options with comparably low cost exist, choose the one with the lowest lagoon depth as the baseline lagoon design.

In applying Step 3 of the BioCarbon Additionality Tool, baseline alternatives for managing the manure shall take into consideration the following additional guidance to compare the economic or financial attractiveness for Step (b) above.

To compare the economic attractiveness without revenues from VCCs for all possible anaerobic lagoon design options that are identified, and in applying the investment analysis the IRR shall be used as an indicator. The following parameters inter alia shall be explicitly documented:

(a) Land cost;

(b) Engineering, procurement and construction cost;

(c) Labour cost;

(d) Operation and maintenance cost;

(e) Administration cost;

(f) Fuel cost;

(g) Capital cost and interest;

(h) Revenue from electricity sales;

(i) All other costs of implementing the technology of each lagoon design option;

(j) All revenues generated by the implementation of the proposed technology (including energy savings due to captive use of biogas as fuel for either electricity or heat generation at the project site, revenue on account of avoided water consumption, fossil fuel replacement, sale of concentrated solids as fertilizers, subsidies/fiscal incentives etc.).

10.5.3 Rationale for Baseline Design Choice in Greenfield Facilities

In greenfield facilities, the restriction of the baseline scenario to uncovered anaerobic lagoons is grounded in plausibility, conservativeness, and environmental integrity considerations.

In many livestock production systems, uncovered anaerobic lagoons represent the lowest-cost, technically feasible, and historically prevalent manure management option in the absence of methane recovery. This is particularly the case in confined livestock operations located in warm or temperate climates where anaerobic storage is operationally simple and economically accessible.

Allowing multiple hypothetical baseline configurations in greenfield conditions may introduce artificial discretion and increase the risk of non-representative or inflated baseline emissions. By restricting the baseline to the least-cost technically feasible anaerobic lagoon design—subject to documented economic assessment and regulatory compliance—this methodology ensures that the selected baseline reflects a realistic Business-as-Usual (BAU) outcome rather than a theoretical construct.

Furthermore, the baseline design is determined through a transparent investment analysis in accordance with the BioCarbon Additionality Tool, ensuring that the selected lagoon configuration represents the most economically plausible alternative without carbon revenues.

This approach enhances methodological consistency, reduces discretion, and prevents over-crediting by anchoring baseline determination in documented economic and regulatory conditions.

In all cases, the final emission reductions remain structurally capped by the methane demonstrably captured and managed under the project scenario, thereby ensuring that credited mitigation outcomes cannot exceed physically realized methane management performance.

10.6 Identification of the Baseline Scenario for Electricity and Heat Generation

In addition to the alternative baseline scenarios identified for managing the manure, alternative scenarios for the use of gas generated from an anaerobic digester (biogas) shall also be identified if this is an aspect of the project activity:

For electricity generation, alternative(s) shall include, inter alia:

a) E1: Electricity generation from biogas, undertaken without being registered as BCR project activity;

b) E2: Electricity generation in existing or new renewable based captive power plant(s);

c) E3: Electricity generation in existing and/or new grid-connected power plant;

d) E4: Electricity generation in an off-grid fossil fuel fired captive power plant;

e) E5: Electricity generation in existing and/or new grid-connected power plant and fossil fuel fired captive power plant(s).

Baseline emissions due to electricity generation can be accounted for only if the baseline scenario is E3, E4 and E5.

For heat generation, alternative(s) shall include, inter alia:

(a) H1: Heat generation from biogas undertaken without being registered as BCR project activity;

(b) H2: Heat generation in existing or new fossil fuel fired cogeneration plant(s);

(c) H3: Heat generation in existing or new renewable based cogeneration plant(s);

(d) H4: Heat generation in existing or new on-site or off-site fossil fuel-based boiler(s) or air heater(s);

(e) H5: Heat generation in existing or new on-site or off-site renewable energy-based boiler(s) or air heater(s);

(f) H6: Any other source, such as district heat; and

(g) H7: Other heat generation technologies (e.g. heat pumps or solar energy);

(h) Baseline emissions due to heat generation can be accounted for only if the baseline scenario is H4.

10.6.1 Baseline validity reassessment

In order to ensure alignment with evolving regulatory frameworks, national climate commitments, and progressive increases in mitigation ambition, the continued validity of the baseline scenario shall be assessed at each verification event. This reassessment concerns baseline plausibility and not automatic recalculation of baseline emissions.

This reassessment shall determine whether material changes have occurred that could affect the plausibility of the baseline scenario, including but not limited to:

(a) Adoption, amendment, or effective enforcement of new mandatory regulations requiring methane capture or alternative manure management systems;

(b) Updates to the host country's Nationally Determined Contribution (NDC) or related sectoral climate strategies;

(c) Significant sector-wide technological adoption altering common practice;

(d) Structural economic or policy shifts that materially affect baseline feasibility.

The reassessment shall focus on plausibility and materiality and shall not require automatic recalculation of baseline emissions unless such material changes are identified.

Materiality shall be assessed in accordance with the materiality provisions defined in the BioCarbon MRV Tool and the applicable verification-level threshold.

Where no material changes are identified, the originally validated baseline scenario shall remain valid.

Where material changes are identified, the baseline scenario shall be reassessed in accordance with the BioCarbon Additionality Tool and the BioCarbon MRV Tool to ensure that baseline emissions remain representative of Business-as-Usual (BAU) conditions and do not exceed them.

All reassessment conclusions shall be transparently documented in the Monitoring Report and subject to independent verification.

10.7 Conservativeness and uncertainty in baseline

Uncertainty associated with baseline methane emissions shall be quantified in accordance with the BioCarbon Uncertainty Management Tool v1.0.

If the relative half-width of the 90% confidence interval exceeds 30%, the excess shall be deducted from the estimated mitigation outcome.

The final verified emission reductions shall reflect any uncertainty adjustment prior to credit issuance.

10.8 Demonstration of additionality

The project activity shall demonstrate additionality in full compliance with the BioCarbon Additionality Tool v1.0.

The project holder shall apply the step-wise procedure established in the Tool, including:

(a) Identification of alternative scenarios;
(b) Barrier analysis and/or investment analysis;
(c) Mandatory common practice analysis;
(d) Selection of the baseline scenario.

10.8.1 Regulatory surplus

The project activity shall not be mandated by binding legislation or regulation that is effectively enforced.

If regulations require methane capture or anaerobic digestion:

The project shall demonstrate that enforcement levels are below 50%; or

The project shall demonstrate that compliance is not effectively implemented in practice.

Projects that are fully legally required and enforced shall not be eligible for crediting.

10.8.2 Barrier analysis (if applied)

If the project holder applies a barrier analysis pathway, the project shall demonstrate that:

(a) One or more material barriers prevent implementation of anaerobic digestion in the absence of carbon revenues;
(b) At least one alternative scenario does not face the same barriers;
(c) Carbon credit revenues play a decisive role in overcoming the identified barriers.

Acceptable barriers may include:

(a) Financial barriers (lack of access to capital);
(b) Technological barriers (lack of operational expertise);
(c) Institutional barriers (absence of enabling policy frameworks).
(d) Claims shall be supported by documented evidence.

10.8.3 Investment analysis (if applied)

If the investment analysis pathway is selected, the project holder shall demonstrate that:

(a) The project is not financially attractive without carbon revenues;
(b) The selected financial indicator (e.g., IRR, NPV, payback period) is below the applicable benchmark;
(c) Carbon revenues are required to reach financial viability.

Sensitivity analysis shall be conducted on key financial variables.

10.8.4 Common practice analysis (mandatory)

The project holder shall demonstrate that biomethanisation with methane capture is not common practice within the applicable geographic area.

The project shall be considered common practice if:

(a) Market penetration thresholds shall be assessed in accordance with the BioCarbon Additionality Tool; and
(b) Comparable activities exist under similar conditions.

If the project is deemed common practice, it shall not be eligible unless essential and material differences are demonstrated.

10.9 Documentation requirements

The project holder shall document:

(a) All identified alternative scenarios;
(b) Evidence of prevailing manure management practices;
(c) Legal and regulatory context;
(d) Results of barrier and/or investment analysis;
(e) Common practice assessment;
(f) Baseline emission calculations;
(g) Uncertainty analysis and conservative adjustments.

All documentation shall be submitted for independent validation and verification in accordance with the BioCarbon MRV Tool v2.0.

10.10 Contribution to Nationally Determined Contributions (NDC)

Project holders shall demonstrate how the mitigation activity contributes to the host country's Nationally Determined Contribution (NDC), in accordance with the BioCarbon Standard and the BioCarbon Avoiding Double Counting (ADC) Tool.

Such demonstration shall include:

(a) Identification of the relevant sectoral or national mitigation targets to which the activity contributes;
(b) Confirmation that the project activity is consistent with national climate policies and sectoral development plans;
(c) Documentation of how emission reductions are accounted for within the host country's inventory framework, where applicable.

The baseline scenario and additionality assessment shall consider relevant national climate strategies and NDC updates to ensure that the project activity does not generate credits for emission reductions that are already mandated or fully embedded in national policy frameworks.

This provision does not require that the project activity be explicitly referenced in the host country's NDC; however, alignment with national mitigation objectives shall be transparently demonstrated in the Project Document.

Where emission reductions are authorized for international transfer under Article 6.2, the project shall comply with all corresponding adjustment requirements defined by the host country and the BioCarbon Standard.

11 Quantification of baseline and project emissions

11.1 Global Warming Potentials (GWP)

Global Warming Potentials (GWP) for CH_4 and N_2O used in this methodology shall be those formally adopted by the BioCarbon Standard at the time of validation or verification.

At the date of issuance of Version 2.0 of this methodology, the BioCarbon Standard adopts the following 100-year GWP values consistent with the IPCC Fifth Assessment Report (AR5):

CH_4: 28

N_2O: 265

If the BioCarbon Standard updates the adopted GWP values in a future revision (e.g., transition to IPCC AR6 or subsequent assessment reports), the updated values shall apply prospectively from the effective date specified in the relevant program-level instrument.

Such updates shall not apply retroactively to monitoring periods that have already been verified and for which Verified Carbon Credits (VCCs) have been issued.

In all cases, the GWP values applied shall be transparently documented in the Monitoring Report and shall be consistent with the version of the BioCarbon Standard in force at the time of verification.

11.2 Baseline emissions calculation

Baseline emissions are calculated as the sum of CH4 and N2O emissions that would occur in the baseline animal waste treatment system and CO2 emissions arising from heat and electricity consumption. Hence:

$$BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{\frac{elec}{heat},y}$$ **Equation 1**

Where:

BE_y	=	Total baseline emissions in year y, in tCO_2e/year
$BE_{CH4,y}$	=	Baseline methane emissions attributable to animal waste treatment in year y, in tCO_2e/year
$BE_{N2O,y}$	=	Baseline N_2O emissions attributable to animal waste treatment in year y, in tCO_2e/year
$BE_{\frac{elec}{heat},y}$	=	Baseline CO_2 emissions from electricity and/or heat generated/consumed in the baseline, in tCO_2e/year

Baseline CO_2 emissions from electricity and heat shall only be included where the selected baseline scenario involves fossil fuel-based or grid electricity generation.

11.2.1 Methane emissions from animal waste treatment ($BE_{CH4,y}$)

Baseline methane emissions from animal waste treatment may be calculated by using one of the following options:

(a) Using the amount of waste that would decay anaerobically in the absence of the project activity. For this calculation, manure characteristics include the amount of volatile solids (VS) produced by the livestock as well as information on manure management systems is required.

(b) Using the amount of manure that would decay anaerobically in the absence of the project activity based on the direct measurement of quantity of manure treated together with the volatile content of the treated manure ($VS_{manure,LT}$)

Calculation of $BE_{CH4,y}$ through option (a) shall be executed as follows:

$$BE_{CH_{4},y} = GWP_{CH_4} \times \rho_{CH_{4},n} \times \sum_{j,LT} (MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{Bl,j})$$ **Equation 2**[6]

Where:

$BE_{CH_{4},y}$	=	Annual baseline methane emissions in tCO_2e/y
GWP_{CH_4}	=	Global Warming Potential (GWP) of CH_4
$\rho_{CH_{4},n}$	=	CH_4 density (6.7×10^{-4} t/m^3 at room temperature (20ºC) and 1 atm pressure)
MCF_j	=	Annual methane conversion factor (MCF) for the baseline AWMS j from 2019. Refinement to the 2006 IPCC Guidelines (as updated in July 2023). the Table 10.17 (Updated), Chapter 10, Volume 4.[7]
$B_{0,LT}$	=	Maximum methane yield from manure for livestock type LT, in $m^3CH_4/kgVS$ from 2019 Refinement to the 2006 IPCC Guidelines (, as updated in July 2023), Table 10.16A(Updated), Chapter 10, Volume 4
$N_{LT,y}$	=	Annual average number of animals of type LT for the year y, expressed in numbers

[6] These emissions shall be separately estimated for each farm and then summed up.

[7] Annex 5 of this methodology.

$VS_{LT,y}$	=	Annual volatile solid for livestock LT entering all AWMS [on a dry matter weight basis (kg-VS-dm/animal/year)], as estimated below
$MS\%_{Bl,j}$	=	Fraction of manure handled in AWMS type *j* in the baseline scenario

Estimation of $VS_{LT,y}$, $B_{0,LT}$ and MCF_j:

These parameters shall be determined in the following ways. If the default values are taken from the IPCC Guidelines, the latest refinement to the IPCC Guidelines shall be taken into consideration, and equivalent values shall be used.

$\boldsymbol{VS_{LT,y}}$ can be determined in one of the following ways, stated in the order of preference:

1) Using published country specific data. If the data is expressed in kg dm per day, multiply the value with nd_y (number of days the central treatment plant was operational in year *y*);
2) Estimation of VS based on dietary intake of livestock;

$$VS_{LT,y} = \left[GE_{LT} \times \left(1 - \frac{DE_{LT}}{100}\right) + (UE \times GE_{LE})\right] \times \left[\left(\frac{1 - ASH}{ED_{LT}}\right)\right] \times nd_y \qquad \textbf{Equation 3}$$

Where:

$VS_{LT,y}$	=	Annual volatile solid excretions on a dry matter weight basis (kg-dm/animal/year)
GE_{LT}	=	Daily average gross energy intake in MJ/day; on dry matter basis (Calculated as per Equation 10.16. Chapter 10, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) or use default value of 18.45 MJ/kg of dry matter if field specific information is not available)
DE_{LT}	=	Digestible energy of the feed in percent (2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023, Table 10.2 (Updated), Chapter 10, Volume 4)

$UE \times GE_{LE}$	=	Urinary energy expressed as fraction of GE. Typically 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available
ASH	=	Ash content of manure calculated as a fraction of the dry matter feed intake. Use country-specific values where available
ED_{LT}	=	Energy density of the feed in MJ/kg (IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg-dm, which is relatively constant across a wide variety of grain based feeds.) fed to livestock type LT. The project holder will record the composition of the feed to enable the CAB to verify the energy density of the feed
nd_y	=	Number of days the central treatment plant was operational in year y

3) Scaling default IPCC values VSdefault to adjust for a site-specific average animal weight as shown in equation below:

$$VS_{LT,y} = \left(\frac{W_{site}}{1000}\right) \times VS_{default} \times nd_y \quad \textbf{Equation 4}$$

Where:

$VS_{LT,y}$	=	Adjusted volatile solid excretion per year on a dry-matter basis for a defined livestock population at the project site in kg-dm/animal/yr
W_{site}	=	Average animal weight of a defined population at the project site (AWMS) in kg
$VS_{default}$	=	Default value (2019 Refinement to IPCC 2006, Table 10.13A (New), Chapter 10, Volume 4 as updated in July 2023 or US-EPA 2002, whichever is lower) for the volatile solid excretion per day on a dry-matter basis for a defined livestock population in kg-VS/1000 kg animal mass/day

nd_y	=	Number of days the central treatment plant was operational in year y

Annual Average number of animals (N_{LT}) can be determined in one of the following ways:

1) Annual stock of animals can be monitored for the estimation of annual average number of animals

$$N_{LT} = N_{da} \times \left(\frac{N_p}{365}\right)$$ **Equation 5**

Where:

N_{LT}	=	Annual average number of animals of type LT for the year y, expressed in numbers
N_{da}	=	Number of days animal is alive in the farm in the year y, expressed in numbers
N_p	=	Number of animals produced annually of type LT for the year y, expressed in numbers

2) If the project holder can monitor in a reliable and traceable way the daily stock of animals in the farm, discounting dead animals and animals discarded from the productive process from the daily stock, then the annual average number of animals (NLT) may be calculated as an average of the daily stock of animals in the farm without considering dead animals and discarded animals.

$$\boldsymbol{N_{LT} = \frac{\sum_1^{365} N_{AA}}{365}}$$ **Equation 6**

Where:

N_{LT}	= Annual average number of animals of type LT for the year y, expressed in numbers
N_{AA}	= Daily stock of animals in the farm, discounting dead and discarded animals.

The following sources shall be used to calculate baseline emissions:

1. 2019 Refinement to the 2006 IPCC Guidelines (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10;
2. US-EPA 2002: Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations, Chapter 8.2[8]

Calculation of $BE_{CH4,y}$ through the Paragraph 34(b) shall be executed as follows:

$$BE_{CH4,y} = GWP_{CH4} \times \rho_{CH4} \times \sum_{j,LT} MCF_j \times B_{0,LT} \times 10^3 \times Q_{manure,j,LT,db,y} \times VS_{manure,LT} \quad \textbf{Equation 7}$$

Where:

$Q_{manure,j,LT,db,y}$	=	Quantity of manure treated from livestock type *LT* and animal manure management system *j* (tonnes/year, dry basis)
$VS_{manure,LT}$	=	Volatile solid content of animal manure from livestock type *LT* and animal manure management system *j* in year *y* (tonnes/tonnes, dry basis)
MCF_j	=	Annual methane conversion factor (MCF) for the baseline AWMSj from 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) Table 10.17 (Updated), Chapter 10, Volume 4
$B_{0,LT}$	=	Maximum methane yield from manure for livestock type *LT*, in $m^3CH_4/kgVS$ from 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023), Table 10.16A(Updated), Chapter 10, Volume 4

Maximum Methane Production Potential ($\boldsymbol{B_{0,LT}}$) can be determined in one of the following ways, stated in the order of preference:

1. Default value as per Tier 1 and 1a approach in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10.

[8] https://nepis.epa.gov/Exe/ZyPDF.cgi/20002UUV.PDF?Dockey=20002UUV.PDF

This value varies by livestock species and diet. Where default values are used, they shall be taken from tables 10.16A (Updated) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10 specific to the country where the project is implemented. The selected $B_{o,LT}$ value shall be clearly justified and reported in the project document.

2. Direct measurement of $B_{o,LT}$ as per Tier 2 approach in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10 :

   (a) ISO 11734:1995;[9] and

   (b) ASTM D 5210-92.[10]

Methane conversion factors ($\boldsymbol{MCF_j}$):

1. The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (as updated in July 2023) MCF values given in table 10.17 (Updated) (Chapter 10, Volume 4) shall be used, which is attached here as Annex 4. MCF values depend on the climate zone where the anaerobic manure treatment facility in the baseline existed. Future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories shall be taken into account;

2. Where default Methane Conversion Factors (MCF) from IPCC guidelines are applied, their associated uncertainty shall be assessed in accordance with the BioCarbon Uncertainty Management Tool v1.0.

   No fixed conservativeness multiplier shall be applied. Instead, total uncertainty shall be quantified at the 90% confidence level and conservative deductions shall be applied where required under the BioCarbon Uncertainty Tool.

3. For subsequent treatment stages, the reduction of the volatile solids during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with volatile solids adjusted for the reduction from the previous treatment stages by multiplying by (1 - R_{VS}), where R_{VS} is the relative reduction of volatile solids from the previous stage. The relative reduction (R_{VS}) of volatile solids depends on the treatment technology and shall be estimated in a

[9] International Organization for Standardization. 1995. Water quality: Evaluation of the 'ultimate' anaerobic biodegradability of organic compounds in digested sludge ISO/DIS 11734. ISO, Geneva.

[10] ASTM D5210 - 92(2007) Standard Test Method for Determining the Anaerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewage Sludge

conservative manner. Default values for different treatment technologies can be found in Table 8.10 of chapter 8.2 in US-EPA (2002)[11]. These values are provided in Annex 1.

11.2.2 N2O emissions from manure management

$$BE_{N_2O,y} = GWP_{N_2O} \times CF_{N_2O-N,N} \times 10^{-3} \times \left(E_{N_2O,D,y} + E_{N_2O,ID,y}\right) \qquad \text{Equation 8}$$

$$E_{N_2O,D,y} = \sum_{j,LT}\left(EF_{N_2O,D,j} \times NEX_{LT,j} \times N_{LT,y} \times MS\%_{Bl,j}\right) \qquad \text{Equation 9}$$

$$E_{N_2O,ID,y} = \sum_{j,LT}\left(\left(EF_{4,j} + EF_{5,j}\right) \times F_{gasm} \times NEX_{LT,y} \times N_{LT,y} \times MS\%_{Bl,j}\right) \qquad \text{Equation 10}$$

Where:

$BE_{N_2O,y}$	=	Annual baseline N_2O emissions in tCO_2e/yr
GWP_{N_2O}	=	Global Warming Potential (GWP) for N_2O
$CF_{N_2O-N,N}$	=	Conversion factor N_2O-N to N_2O (44/28)
$E_{N_2O,D,y}$	=	Direct N_2O emissions in kg N_2O-N/year
$E_{N_2O,ID,y}$	=	Indirect N_2O emissions in kg N_2O-N/year
$E_{N_2O,ID,y}$	=	Direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available, otherwise use default EF_3 from table 10.21, Chapter 10, Volume 4, in the 2019 Refinement to the 2006 IPCC Guidelines

[11] https://nepis.epa.gov/Exe/ZyPDF.cgi/20002UUV.PDF?Dockey=20002UUV.PDF

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for National Greenhouse Gas Inventories, as updated in July 2023)

$NEX_{LT,j}$	=	Is the annual average nitrogen excretion per head of a defined livestock population in kgN/animal/year estimated as described in Annex 6
$N_{LT,y}$	=	Number of animals of type *LT* for the year *y*, expressed in numbers
$MS\%_{Bl,j}$	=	Fraction of manure handled in system *j*, in %
F_{gasm}	=	Percent of managed manure nitrogen for livestock category that volatilizes as NH_3 and NOx in the manure management system
$EF_{4,j}$	=	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O / (kg NH_3-N + NOx-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) (0.01 kg N2O-N/(kg NH3-N +NOx-N volatilized)
$EF_{5,j}$	=	Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3(Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) can be used (0.0075 kg N2O-N/(kg N leaching/runoff)

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by (1 - RN), where RN is the relative reduction of nitrogen from the previous stage. The relative reduction (RN) of nitrogen depends on the treatment technology and shall be estimated in a conservative manner. Default values for different treatment technologies can be found in Chapter 8.2 in USEPA (2002)[12]. These values are provided in Annex 1.

11.2.3 CO2 emissions from electricity and heat within the project boundary

$$BE_{elect/heat,y} = EG_{Bl,y} \times CEF_{Bl,elec,y} + EG_{d,y} \times CEF_{grid} + HG_{Bl,y} \times CEF_{Bl,therm,y}$$ **Equation 11**

Where:

$BE_{elect/heat,y}$	=	Baseline CO_2 emissions from electricity and/or heat used in the baseline, in tCO_2e/year
$EG_{Bl,y}$	=	Amount of electricity in the year y that would be consumed in the absence of the project activity (MWh) for operating all AWMs facilities
$CEF_{Bl,elec,y}$	=	Carbon emissions factor for electricity consumed at the project site in the absence of the project activity (tCO_2e/MWh)
$EG_{d,y}$	=	Amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during the year *y* (MWh)
CEF_{grid}	=	Carbon emissions factor for the grid in the project scenario (tCO_2e/MWh)
$HG_{Bl,y}$	=	Quantity of thermal energy that would be consumed in year y in the absence of the project activity (MJ) using fossil fuel for operating all AWMSs
$CEF_{Bl,therm,y}$	=	CO_2 emissions intensity for thermal energy generation (tCO_2e/MJ)

Determination of $CEF_{Bl,elec}$ and CEF_{grid}:

CEF_{grid} and $CEF_{Bl,elec}$ shall be calculated according to relevant procedure in the "Tool to calculate the emission factor for an electricity system".

[12] https://nepis.epa.gov/Exe/ZyPDF.cgi/20002UUV.PDF?Dockey=20002UUV.PDF

Determination of $CEF_{Bl,therm}$:

$CE_{FBl,therm}$ is the CO_2 emissions intensity for thermal energy generation (tCO2e/MJ). This parameter shall be determined.

Baseline electricity and thermal energy consumption shall be estimated as the average of the historical 3 years' consumption.

11.3 Quantification of project activity emissions

The project activity may employ one or a combination of technologies to treat manure. For instance, the effluent mix could be initially treated in an anaerobic digester/reactor, followed by further processing of the treated waste using an aerobic pond. Each processing step shall be considered as a distinct treatment stage.

Project emissions are estimated as follows:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{Comp,y} + PE_{N_2O,y} + PE_{PL,y} + PE_{flare,y} + PE_{\frac{elec}{heat},y} + PE_{CO_2,Trans,y} + PE_{storage,y}$$

Equation 12

Where:

PE_y	=	Project emissions (tCO_2e/yr)
$PE_{AD,y}$	=	Leakage from treatment stage that captures methane (tCO_2e/yr)
$PE_{Aer,y}$	=	Methane emissions from the aerobic treatment stage (tCO_2e/yr)
$PE_{Comp,y}$	=	Total project emissions due to composting (tCO_2e/yr)
$PE_{N2O,y}$	=	Nitrous oxide emission from project treatment system (tCO_2e/yr)
$PE_{PL,y}$	=	Physical leakage of emissions from biogas network to flare the captured methane or supply to the facility where it is used for heat and/or electricity generation (tCO_2e/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream (tCO_2e/yr)

$PE_{elec/heat,y}$	=	Project emissions from use of heat and/or electricity in the project case (tCO2e/yr)
$PE_{CO_2,Trans,y}$	=	Project emissions from manure road transportation (tCO_2e/yr)
$PE_{storage,y}$	=	Project emissions from manure storage (tCO_2e/yr)

11.4 Methane emissions from AWMS where gas is captured ($PE_{AD,y}$)

For the calculation of methane emissions from AWMS, refer to the relevant procedure in the methodological tool "Project and leakage emissions from anaerobic digesters". In the relevant tool, PEAD,y is equivalent to $PE_{CH4,y}$.

11.5 Methane emissions from aerobic treatment ($PE_{Aer,y}$)

Methane emissions from aerobic treatment can be determined in one of the following ways, stated in the order of preference. For the calculations, IPCC guidelines specify emissions from aerobic lagoons as 0.1% of total methane generating potential of the waste processed.

Option 1:

$$E_{Aer,y} = GWP_{CH_4} \cdot \rho_{CH_4,n} \cdot MCF_{Aer} \sum_{m=1}^{12} (Q_{EM,Aer,m} \cdot VS_{EM,Aer,m} \cdot B_{0,EM,m}) \quad \text{Equation 13}$$

Where:

$PE_{Aer,y}$	=	Methane emissions from the aerobic treatment stage in tCO_2e/yr
GWP_{CH_4}	=	Global Warming Potential (GWP) of CH_4
$\rho_{CH_4,n}$	=	CH_4 density ($6.7 x 10^{-4}$ t/m^3 at room temperature (20 ºC) and 1 atm pressure)
$Q_{EM,Aer,m}$	=	Monthly volume of the effluent entering the aerobic treatment step (m^3/month)

$VS_{EM,Aer,m}$	=	Average monthly volatile solids (VS) concentration of the effluent entering the aerobic treatment step (ton VS/m^3)
$B_{0,EM,m}$	=	Average monthly CH_4 production capacity of effluent manure entering the aerobic treatment stage (m$^3CH_4$/ton-VS)
MCF_{Aer}	=	Methane Conversion Factor (MCF) for aerobic system (0.1%)

Option 2:

$$PE_{Aer,y} = GWP_{CH4} \times \rho_{CH4} \times 0.001 \times F_{Aer} \times \left[\prod_{n=1}^{N}(1 - R_{VS,n})\right] \times \sum_{j,LT}(B_{0,LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j) \quad \textbf{Equation 14}$$

Where:

GWP_{CH4}	=	Global Warming Potential (GWP) of CH_4 (t CO_2e/tCH_4)
$R_{VS,n}$	=	Fraction of volatile solid degraded in AWMS treatment method *n* of the *N* treatment steps prior to waste being treated (fraction)
ρ_{CH4}	=	Density of CH_4 (t/m^3)
F_{Aer}	=	Fraction of volatile solid directed to aerobic system (fraction)
LT	=	Type of livestock[13]
$B_{0,LT}$	=	Maximum methane producing potential of the volatile solid generated by animal type *LT* (m$^3CH_4$/kg dm)

[13] For the main categories of livestock types, refer to Table 10.1 (Updated) in Volume 4, Chapter 10, of the IPCC 2019 guidelines.

$VS_{LT,y}$	=	Annual volatile solid excretion livestock type *LT* entering all AWMS on a dry matter weight basis in (kg - dm/animal/yr)
N_{LT}	=	Annual average number of animals of type *LT* for the year *y* (number)
$MS\%_j$	=	Fraction of manure handled in system *j* in the project activity (fraction)

The project activity may result in sludge accumulation. Sludge requires removal and has VS. Sludge must be treated through thermo-mechanical drying or composting prior to its final disposal/usage. The same procedure shall be applied to suspended solids removed during the treatment process. No GHG emissions are expected from the thermo-mechanical drying process, except those from eventual fossil fuel consumption.

11.6 Methane emissions from composting ($PE_{comp,y}$)

Methane emissions from composting shall be estimated as follows:

$$PE_{Comp,y} = PE_{Comp,CH_4,y} + PE_{Comp,N_2O,y}$$

Equation 15

$$PE_{Comp,CH_4,y} = GWP_{CH_4} \times \rho_{CH_4,n} \times MCF_{res} \times \sum_{m=1}^{12} (Q_{Comp,m}^{in} \times VS_{res,m} \times B_{0,res,m})$$

Equation 16

Where:

$PE_{Comp,CH_4,y}$	=	Methane emissions from composting in tCO_2e/yr
GWP_{CH_4}	=	Global Warming Potential (GWP) of CH_4
$Q_{Comp,m}^{in}$	=	Monthly quantity of residues entering the composting plant in a dry matter basis (ton/month)

$B_{0,res,m}$	=	Average monthly CH_4 production capacity of residues entering the composting step, in m^3 CH_4/ton-VS
MCF_{res}	=	Methane Conversion Factor (MCF) for composting system as per 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, Table 10.17 (Updated)
$VS_{res,m}$	=	Average monthly volatile solids (VS) concentration of the residue entering the composting step (ton VS/ton)
$\rho_{CH_4,n}$	=	Density of methane at normal (at room temperature 20°C and 1 atm pressure) conditions (6.7×10^{-4} t/m^3)

The measure of the residues B_0 shall be directly done as described in:

(a) ISO 11734:1995[14] and
(b) ASTM D 5210-92.[15]

If the project activity involves the treatment of animal wastes N_2O emissions may occur during the composting process and shall be accounted as follows:

$$PE_{Comp,N_2O,y} = GWP_{N_2O} \times CF_{N_2O-N,N} \times \left(PE_{Comp,N_2O,D,y} + PE_{Comp,N_2O,ID,y}\right) \quad \textbf{Equation 17}$$

$$PE_{Comp,N_2O,D,y} = EF_{N_2O,Comp,D} \times 10^{-3} \times \sum_{m=1}^{12} [N]_{Comp,m}^{in}) \quad \textbf{Equation 18}$$

[14] International Organization for Standardization. 1995. Water quality: Evaluation of the 'ultimate' anaerobic biodegradability of organic compounds in digested sludge ISO/DIS 11734. ISO, Geneva.

15 ASTM D5210 - 92(2007) Standard Test Method for Determining the Anaerobic Biodegradation of Plastic Materials in the Presence of Municipal Sewage Sludge.

$$PE_{Comp,N_2O,ID,y} = (EF_4 + EF_5) \times 10^{-3} \times \left\{ \sum_{m=1}^{12} \left[\left(Q_{Comp,m}^{in} \times [N]_{Comp,m}^{in} \right) - \left(Q_{Comp,m}^{out} \times [N]_{Comp,m}^{out} \right) \right] - PE_{Comp,N_2O,D,y} \right\}$$

Equation 19

Where:

$PE_{Comp,N_2O,y}$	=	Total project N_2O emissions due to composting in tCO_2e/yr
$PE_{Comp,N_2O,D,y}$	=	Total project direct N_2O emissions due to composting in tN-N_2O/yr
$PE_{Comp,N_2O,ID,y}$	=	Total project indirect N_2O emissions due to composting in tN-N_2O/yr
GWP_{N_2O}	=	Global Warming Potential (GWP) for N_2O
$CF_{N_2O-N,N}$	=	Conversion factor N_2O-N to N_2O (44/28)
$EF_{N_2O,Comp,D}$	=	Direct N_2O emission factor for composting in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available. Otherwise use default EF_3 in Volume 4, Chapter 10, Table 10.21 (Updated) in 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023)
EF_4	=	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O / (kg NH_3-N + NOx-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 (0.01 kg N2O-N/(kg NH3-N +NOx-N volatilised)

EF_5	=	Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used (0.0075 kg N2O-N/(kg N leaching/runoff)
$Q_{Comp,m}^{in}$	=	Monthly quantity of residues entering the composting plant in a dry matter basis (ton/month)
$[N]_{Comp,m}^{in}$	=	Monthly total nitrogen concentration in the residues entering the composting plant (kg N/ton residue)
$Q_{Comp,m}^{out}$	=	Monthly quantity of composted residues produced, in a dry matter basis (ton/month)
$[N]_{Comp,m}^{out}$	=	Monthly total nitrogen concentration in composted residues produced (kg N/ton residue)

11.7 N2O emission from the central treatment plant ($PE_{N2O,y}$)

$$PE_{N_2O,y} = GWP_{N_2O} \times CF_{N_2O-N,N} \times 10^{-3} \times \left(E_{N_2O,D,y} + E_{N_2O,ID,y}\right)$$ **Equation 20**

$$E_{N_2O,D,y} = \sum_{n} EF_{N_2O,D,n} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right)$$ **Equation 21**

$$E_{N_2O,ID,y} = EF_{N_2O,ID} \times \sum_{n} F_{gasm,j} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right)$$ **Equation 22**

Where:

$PE_{N_2O,y}$	=	Annual project N_2O emissions in tCO_2e/yr
GWP_{N_2O}	=	Global Warming Potential (GWP) for N_2O
$CF_{N_2O-N,N}$	=	Conversion factor N_2O-N to N_2O (44/28)
$E_{N_2O,D,y}$	=	Direct N_2O emission in kg N_2O-N/year
$E_{N_2O,ID,y}$	=	Indirect N_2O emission in kg N_2O-N/year
$EF_{N_2O,D,n}$	=	Direct N_2O emission factor for the treatment stage n of the central treatment plant in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available. Otherwise use default EF_3 in Volume 4, Chapter 10, table 10.21 (Updated) in 2019 Refinement to the 2006 IPCC guidelines, as updated in July 2023)
$Q_{EM,m}$	=	Monthly volume of the feedstock entering the central plant (m^3/month)
$[N]_{EM,m}$	=	Monthly total nitrogen concentration in the feedstock (kg N/m^3) entering the treatment plant
$EF_{N_2O,ID}$	=	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N and NOx-N emitted, estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC guidelines, as updated in July 2023 can be used
$F_{gasm,j}$	=	Percent of total nitrogen that volatilises as NH_3 and NOx in the treatment stage *j*

For subsequent treatment stages, the nitrogen reduction during each stage is estimated based on referenced data for different treatment types. Emissions from the following treatment stage are then calculated using the approach detailed above, adjusting the nitrogen content to account for the reduction from prior stages. This is done by multiplying the remaining nitrogen by (1-RN), where RN represents the relative reduction of nitrogen from the preceding stage. The relative reduction (RN) of nitrogen is contingent upon the treatment technology and shall be conservatively estimated. Default values for RN are provided in Annex 1. Alternatively, RN can be determined through direct monitoring of the nitrogen concentration in the effluent mix after each treatment step.

11.8 Physical leakage from distribution network of the captured methane in ($PE_{PL,y}$)

This clause addresses biogas leakage within the biogas process. The total captured methane directed to the flare, gas engines, and boiler—as measured according to the monitoring plan—must be reconciled annually with the total methane production, as metered at the output of the methane-generating digester. Any discrepancy between the measured value of produced methane and the sum of that utilized in flaring, electricity generation, or heating is to be accounted for as leakage from the pipeline system.

In addition, any leakage due to venting from the digester valves shall be accounted for as leakage from biogas process. For this purpose, anaerobic digester valves shall be equipped with flow meters.

Physical leakage from the pipeline and venting system determination in the project document shall be conducted using one of the following three options:

If the biogas is solely flared and the pipeline from the collection point to the flare is short (i.e., less than 1 km, for onsite delivery only), a single flow meter can be used. In such cases, physical leakage may be assumed to be negligible.

If national and/or sectoral legislation and regulations mandate stringent leak prevention throughout the pipeline and require regular inspections, physical leakage may be deemed negligible. However, the Designated Operational Entity (CAB) must validate this assumption.

In scenarios where the biogas pipeline system operates under negative pressure (e.g., with blowers installed on the biogas line), leakage from the pipeline system would technically not be feasible, and thus physical leakage may be considered negligible. The presence of a negative pressure environment must be validated by the CAB through the assessment of technical documents and process flows.

11.9 Project emissions from flaring of the residual gas stream ($PE_{Flare,y}$)

The combustion of biogas methane may give rise to significant methane emissions as a result of incomplete or inefficient combustion.

Project emissions from flaring of the residual gas stream shall be determined following the procedure described in the "Methodological Tool: Project emissions from flaring". If the flare is used only in emergency, and the quantity of flared biogas is monitored via flow meter/s, the emissions resulting from flaring might be excluded from the project emissions calculations. In such cases, the flared biogas would not be claimed into the project's ERR calculation.

11.10 Project emissions from heat use and electricity use ($PE_{elec/heat,y}$)

Project emissions from heat and electricity use shall be accounted for as follows:

$$PE_{\frac{elec}{heat},y} = PE_{Elec,y} + \sum_{j} PE_{heat,j,y}$$ **Equation 23**

Where:

$PE_{Elec,y}$ = Are the emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{Elec,y} = PE_{EC,y}$) will be calculated following the latest version of "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". In case, the electricity consumption is not measured then the electricity consumption shall be estimated as follows:

$EC_{PJ,y} = \sum_i CP_{i,y} \times 8760$, where $CP_{i,y}$ is the rated capacity (in MW) of electrical equipment i used for project activity

$PE_{heat,j,y}$	=	Are the emissions from consumption of heat in the project case. The project emissions from fossil fuel combustion ($PE_{heat,j,y}$ = $PE_{FC,j,y}$) will be calculated following the latest version of "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the plant established as part of the project activity, as well as any other on-site fuel combustion for the purposes of the project activity

11.11 Project emissions from road transportation ($PE_{CO2,trans,y}$)

The project emissions from manure transportation shall account for all movements including the transport of feedstocks, including other organic co-digested materials, from their collection points to the central treatment plant, as well as the distribution of treated effluent or residue from the plant to the agricultural fields for application. These emissions are to be calculated based on the total quantity of consumed fuel and the applicable fuel emission factors, as follows:

Project emissions from manure transportation from the collection points to the central treatment plant, and vice versa, are to be calculated using total quantity of consumed fuel and the fuel emission factor, as follows:

$$PE_{CO_2,Trans,y} = \left\{ \sum_i (FC_{i,f}) \times \left[\sum_f NCV_f \times EF_{CO_2,f} \times \rho_{i,f} \right] \right\} \quad \textbf{Equation 24}$$

Where:

$PE_{CO_2,Trans,y}$	=	Project emissions from manure (and treated effluent) road transportation in tCO_2e/yr
$FC_{i,f}$	=	Total quantity of consumed fuel type f in volume units in year y (liter)
NCV_f	=	Net calorific value of fuel type f in TJ per volume or mass units
$EF_{CO_2,f}$	=	CO_2 emission factor of the fossil fuel type f used in transportation vehicles, (tCO_2e/TJ)

$\rho_{i,f}$	=	Density of fuel type f in mass per volume units (kg/liter)

Emissions resulting from the road transportation of treated manure shall be calculated as previously described. These emissions are considered project emissions if the final destination and the routes between the treatment plant and the farms are within the project boundary. If not, such emissions shall be categorized as leakage ($LE_{CO2,Trans,y}$), which is to be calculated using the same method outlined above.

11.12 Project emissions from manure storage ($PE_{storage,y}$)

In instances where tank trucks are utilized for residue collection, there may be a necessity to temporarily store these materials in tanks between collection intervals. This methodology is applicable only when residues are stored in **outdoor open tanks** and if the manure remains in these tanks for more than 24 hours. Were project holders select alternative storage solutions, they shall submit proposed amendments to this methodology. Methane emissions that occur during the storage of residues shall be calculated as follows:

$$PE_{storage,y} = GWP_{CH_4} \times \rho_{CH_4,n} \times \sum_{LT,l}\left[\frac{365}{AI_l}\sum_{d=1}^{AI}\left(N_{LT} \times VS_{LT,d} \times MS\%_l \times \left(1 - e^{-k(AI_l - d)}\right) \times MCF_l \times B_{0LT}\right)\right]$$

Equation 25

Where:

$PE_{storage,y}$	=	Annual project emission in manure storage tanks in tCO_{2e}/yr
GWP_{CH_4}	=	Global warming potential of methane
$\rho_{CH_4,n}$	=	Density of methane (6.7×10^{-4} t/m³ at room temperature (20ºC and 1 atm pressure)
AI_l	=	Annual average interval between manure collection procedures at a given storage tank l (days)
N_{LT}	=	Number of animals of type *LT* during a year *y*, expressed in numbers

$VS_{LT,d}$	=	Amount of volatile solid production by type of animal *LT* in a day (kg VS/head/d)
$MS\%_l$	=	Fraction of volatile solids (%) handled by storage tank *l*
k	=	Degradation rate constant (0.069). Value derived from established manure degradation models.
d	=	Days for which cumulative methane emissions are calculated; *d* can vary from 1 to 45 and to be run from 1 up to AI (average interval between manure collection procedure)
MCF_l	=	Annual methane conversion factor for the project manure storage tank *l* from 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) Table 10.17 (Updated), Chapter 10, Volume 4
B_{0LT}	=	Maximum methane yield from manure for livestock type *LT*, in $m^3CH_4/kgVS$ from 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023), Table 10.16A(Updated), Chapter 10, Volume 4

11.13 Quantification of leakage emissions

Leakage refers to net increases in greenhouse gas (GHG) emissions occurring outside the project boundary that are attributable to the implementation of the project activity.

In this methodology, leakage may arise from:

(i) land application of treated effluent or residues outside the project boundary; and

(ii) the handling or disposal of organic materials co-digested with animal manure, where such materials would otherwise have followed an alternative baseline management pathway.

Leakage emissions shall be calculated as the net difference between emissions occurring under the project scenario and those that would have occurred under the baseline scenario. Only positive net differences shall be considered as leakage.

Net leakage emissions of N_2O and CH_4 shall only be accounted for where they are positive.

CO_2 emissions due to the road transportation of sludge or treated effluent outside the project boundary may also be considered as leakage if it is possible to monitor the amount of diesel utilized for transportation of treated effluent separately. Such emissions are calculated in the same as depicted in the project emissions section.

$$LE_y = (LE_{P,N2O} - LE_{B,N2O}) + (LE_{P,CH4} + LE_{B,CH4,CD} - LE_{B,CH4})$$

Equation 26

Where:

LE_y	=	Leakage emissions for the year *y*, in tCO_2e/year
$LE_{P,N2O,y}$	=	N_2O emissions released during project activity from land application of the treated residues, in tCO_2e/year
$LE_{B,N2O,y}$	=	N_2O emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year
$LE_{P,CH4,y}$	=	CH_4 emissions released during project activity from land application of the treated residues, in tCO_2e/year
$LE_{B,CH4,y}$	=	CH_4 emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year
$LE_{B,CH4,CD,y}$	=	CH_4 emissions occurring in year *y* generated from waste disposal at a solid waste disposal site (SWDS) during a time period ending in year *y*, in tCO_2e/year

11.14 Estimation of leakage N2O emissions

The baseline case N_2O emissions are estimated according to the sum of nitrogen excretion of the livestock types included in the project boundary and to the nitrogen removal capacity of the baseline AWMS, by using the equations below.

$$LE_{B,N_2O} = GWP_{N_2O} \times CF_{N_2O-N,N} \times 10^{-3} \times (LE_{B,N_2O,land} + LE_{B,N_2O,runoff} + LE_{B,N_2O,vol})$$

Equation 27

$$LE_{B,N_2O,land} = EF_1 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{j,LT}(N_{LT,y} \times NEX_{LT} \times MS\%_{Bl,j})$$

Equation 28

$$LE_{B,N_2O,runoff} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{j,LT}(N_{LT,y} \times NEX_{LT} \times MS\%_{Bl,j})$$

Equation 29

$$LE_{B,N_2O,vol} = EF_4 \times F_{gasm} \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{j,LT}(N_{LT,y} \times NEX_{LT} \times MS\%_{Bl,j})$$

Equation 30

Where:

LE_{B,N_2O}	=	N_2O emissions released during baseline scenario from land application of the treated manure, in tCO_2e/year
GWP_{N_2O}	=	Global Warming Potential (GWP) for N_2O
$CF_{N_2O-N,N}$	=	Conversion factor (= 44/28)
$LE_{B,N_2O,land}$	=	Baseline direct N_2O emissions from application of manure waste, in kg N_2O-N/year
$LE_{B,N_2O,runoff}$	=	Baseline N_2O emissions due to leaching and run-off, in kg N_2O-N/year
$LE_{B,N_2O,vol}$	=	Baseline N_2O emissions due to nitrogen volatilization as NH_3 and NOx, in kg N_2O-N/year
F_{gasm}	=	Fraction of total N that volatizes as NH_3 and NOx in kg NH_3-N and NOx-N per kg of N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) can be used

$N_{LT,y}$	=	Number of animals of type LT for the year y, expressed in numbers
NEX_{LT}	=	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 6
$MS\%_{Bl,j}$	=	Fraction of manure handled in system j in the baseline scenario
EF_1	=	Emission factor for direct emission of N_2O from soils in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.1 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines (as updated in July 2023) can be used
$R_{N,n}$	=	Fraction of N that is reduced in the Baseline AWMS. The relative reduction of nitrogen depends on the treatment technology and shall be estimated in a conservative manner. Default values for different treatment technologies can be found in Annex 1
EF_5	=	Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used
F_{leach}	=	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff shall be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used
EF_4	=	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O / (kg NH_3-N + NOx-N volatilized)], estimated with site-specific,

regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023.

In contrast, the project case N_2O emissions are estimated through the direct measurement of the treated effluent disposed outside the project boundary, by using the following equations:

$$LE_{P,N_2O} = GWP_{N_2O} \times CF_{N_2O-N,N} \times 10^{-3} \times \left(LE_{P,N_2O,land} + LE_{P,N_2O,runoff} + LE_{P,N_2O,vol}\right)$$ **Equation 31**

$$LE_{P,N_2O,land} = EF_1 \times \sum_{m=1}^{12} \left(Q_{DE,m} \times [N]_{DE,m}\right)$$ **Equation 32**

$$LE_{P,N_2O,runoff} = EF_5 \times F_{leach} \times \sum_{m=1}^{12} \left(Q_{DE,m} \times [N]_{DE,m}\right)$$ **Equation 33**

$$LE_{P,N_2O,vol} = EF_4 \times F_{gasm} \times \sum_{m=1}^{12} \left(Q_{DE,m} \times [N]_{DE,m}\right)$$ **Equation 34**

Where:

$LE_{P,N_2O,y}$	=	N_2O emissions released during project scenario from land application of the treated residues, in tCO_2e/year
GWP_{N_2O}	=	Global Warming Potential (GWP) for N_2O
$CF_{N_2O-N,N}$	=	Conversion factor (44/28)

$LE_{P,N_2O,land}$	=	Project case direct N_2O emission from application of treated effluent, in kg N_2O-N/year
$LE_{P,N_2O,runoff}$	=	Project case N_2O emission due to leaching and run-off, in kg N_2O-N/year
$LE_{P,N_2O,vol}$	=	Project case N_2O emissions due to nitrogen volatilization as NH_3 and NOx, in kg N_2O-N/year
F_{gasm}	=	Fraction of total N that volatizes as NH_3 and NOx in kg NH_3-N and NOx-N per kg of N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used
$Q_{DE,m}$	=	Total monthly quantity of treated effluent / residue disposed outside the project boundary (DE) (tons of dry matter)
$[N]_{DE,m}$	=	Mean monthly nitrogen concentration of treated effluent / residue disposed outside the project boundary (DE) (kg N/m^3 or kg N/ton of dry matter)
EF_1	=	Emission factor for direct emission of N_2O from soils in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.1 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used
EF_5	=	Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used
F_{gasm}	=	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff shall be estimated with site-specific, regional or national data if such data is available. Otherwise,

default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023 can be used

EF_4	=	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O / (kg NH_3-N + NOx-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 11.3 (Updated), Chapter 11, Volume 4 of 2019 Refinement to the 2006 IPCC Guidelines, as updated in July 2023

11.15 Methane emissions from disposal of treated residues

Leakage methane emissions from land application of treated residues are calculated as follows:

$$LE_{B,CH_4,y} = GWP_{CH4} \times \rho_{CH4,n} \times MCF_d \times \left[\prod_{n-1}^{N}(1 - R_{VS,n})\right] \sum_{j,LT}\left(B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{BL,j}\right)$$

Equation 35

$$LE_{P,CH_{4,y}} = GWP_{CH_4} \times \rho_{CH_4,n} \times MCF_d \cdot \sum_{m=1}^{12}(Q_{DE,m} \times VS_{DE,m}) \times 10^3 \times \frac{\sum_{LT}(B_{0,LT} \cdot N_{LT,y} \cdot VS_{LT,y})}{\sum_{LT}(N_{LT,y} \cdot VS_{LT,y})}$$

Equation 36

In the case of utilizing option (b) for $BE_{CH_{4},y}$ calculations, methane emissions from disposal of treated residues must be calculated as follows:

Leakage methane emissions from land application of treated residues are calculated as follows:

$$LE_{B,CH_4,y} = GWP_{CH4} \times \rho_{CH4,n} \times MCF_d \times \left[\prod_{n-1}^{N}(1 - R_{VS,n})\right] \sum_{j,LT} (B_{0,LT} \times Q_{manure,j,LT,db,y} \times VS_{manure,LT} * 1000)$$

Equation 37

$$LE_{P,CH_4,y} = GWP_{CH_4} \times \rho_{CH_4,n} \times MCF_d \cdot \sum_{m=1}^{12}(Q_{DE,m} \times VS_{DE,m}) \times 10^3 \times \frac{\sum_{LT}(B_{0,LT} \cdot Q_{manure,j,LT,db,y} \times VS_{manure,LT})}{\sum_{LT}(Q_{manure,j,LT,db,y} \times VS_{manure,LT})}$$

Equation 38

Where:

$LE_{B,CH_4,y}$	=	Methane leakage emissions in the baseline (tCO_2e/yr)
$LE_{P,CH_4,y}$	=	Methane leakage emissions in the project case ($t\ CO_2e/yr$)
$R_{VS,n}$	=	Fraction of volatile solid degraded in AWMS n prior to sludge being treated. Values for R_{VS} shall be taken from Annex 1
GWP_{CH4}	=	Global Warming Potential (GWP) of CH_4
$\rho_{CH_4,n}$	=	CH_4 density [$6.7x10^{-4}$ t/m³ at room temperature (20 ºC) and 1 atm pressure]
$B_{0,LT}$	=	CH_4 production capacity from manure for livestock type LT, in m3 CH_4/kg-VS, to be chosen based on procedure provided for in the baseline methodology section
$N_{LT,y}$	=	Number of animals of type LT for the year y, expressed in numbers
$VS_{LT,y}$	=	Annual volatile solid for livestock LT entering all AWMS [on a dry matter weight basis (kg-dm/animal/year)]

$MS\%_{BL,j}$	=	Fraction of manure handled in system j in the baseline scenario
$Q_{DE,m}$	=	Total monthly volume of treated effluent / residue disposed outside the project boundary (DE) (tons of dry matter)
$VS_{DE,m}$	=	Monthly volatile solids concentration of the disposed treated effluent / residue (ton VS/m³or ton VS/ton of dry matter)
MCF_d	=	In the absence of site-specific data, MCFd may be conservatively assumed equal to 1. Where data are available, project-specific or IPCC-consistent values shall be applied. This assumption reflects a conservative upper-bound estimate of methane generation potential in unmanaged disposal conditions and ensures that leakage methane is not underestimated.

12 Emission reductions

The emission reduction (ER_y) by the project activity during a given year or the relevant monitoring periods of the project activity is the difference between the baseline emissions (BEy) and the sum of project emissions (PE_y) and leakage (LE_y), as follows:

$$\boldsymbol{ER_y = BE_y - PE_y - LE_y}$$ **Equation 39**

Where:

ER_y	=	Emission reductions in year y (t CO_2e/yr)
BE_y	=	Baseline emissions in year y (t CO_2e/yr)
PE_y	=	Project emissions in year y (t CO_2e/yr)
LE_y	=	Leakage emissions in year y (t CO_2e/yr)

Further, in calculating emissions reductions for Verified Carbon Credits (VCCs) claims, if baseline CH_4 emissions (in tCO_2e) exceed the measured CH_4 emissions (in tCO_2e) from the anaerobic digester(s) in the project scenario, then the latter, which is derived from the product of the biogas flow at the digester(s) outlet and the methane fraction in the biogas, shall be used for emissions reduction calculations.

Therefore, the actual methane captured and utilized or destroyed in the project scenario (MDy – CD_CH4) shall be compared to the baseline methane emissions attributable to manure management (BE_CH4,y). If (MDy – CD_CH4) (in tCO_2e) is lower than (BE_CH4,y), then (MDy – CD_CH4) shall replace (BE_CH4,y) in the emission reduction calculation to ensure that credited CH_4 avoidance does not exceed the methane actually captured and managed.

Actual methane captured can be determined based on the following methods:

a) If the amount of biogas utilized in monitored through flow meters, MDy shall be determined based on equipment efficiency.

$$MD_y = BG_{utilized} \times fv_{CH4,RG,h} \times \rho_{CH4} \times EE_y \times GWP_{CH4} \quad \textbf{Equation 40}$$

Where:

MD_y	=	Actual methane captured (tCO_2)
$BG_{utilized}$	=	Biogas utilized (m^3)
$fv_{CH4,RG,h}$	=	Methane content in biogas in year y (volume fraction)
$EE_{j,y}$	=	Energy conversion efficiency of the project equipment *j* which is determined by adopting one of the following criteria:

- Specification provided by the equipment manufacturer. The equipment shall be designed to utilize biogas as fuel, and efficiency specification is for this fuel. If the specification provides a range of efficiency values, the lowest value of the range shall be used for the calculation;

- Default flare efficiency: In the absence of manufacturer specification, a conservative default efficiency consistent with recognized technical standards may be applied.

b) Alternatively, if project activities utilize the recovered methane for electricity generation and/or heat generation, MD_y may be calculated as follows, based on the sum of monitored electricity generation, and/or heat generation without monitoring methane flow and concentration.

$$MD_y = \frac{EG_y \times 3600 + HG_y}{NCV_{CH4} \times EE_{j,y}} \times \rho_{CH4} \times GWP_{CH4}$$ **Equation 41**

Where:

EG_y	= Total electricity generated from the recovered biogas in year y (MWh)
HG_y	= Total heat generated from the recovered biogas in year y (MJ)
3600	= Conversion factor (1 MWh = 3600 MJ)
NCV_{CH4}	= NCV of methane (MJ/Nm^3) (Unless otherwise specified by the BioCarbon Standard, NCVCH4 may be assumed as 35.9 MJ/Nm^3 consistent with IPCC guidance)

The effect of co-digested organic waste shall be determined as follows:

$$CD_{CH4} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times \sum_{x=1}^{y} Default_x \times W_x)$$ **Equation 42**

Where:

CD_{CH4}	=	Methane generation potential of the organic waste anaerobically co-digested by the project activity during the year x from the beginning of the project activity (x=1) up to the year y (t CO2e/yr)
W_x	=	Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (t)

φ_y = Model correction factor to account for model uncertainties for year y

f_y = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y

13 Leakage identification, quantification and management

13.1 General principles

The project activity shall identify, assess, quantify (where material), and deduct all significant sources of leakage that may occur because of the implementation of the biomethanisation project.

Leakage refers to any increase in greenhouse gas (GHG) emissions occurring outside the project boundary that is attributable to the project activity and that reduces the net mitigation benefit.

Leakage assessment shall:

(a) Be conducted ex-ante at validation;
(b) Be reassessed during each monitoring period;
(c) Be quantified ex-post when material;
(d) Be deducted conservatively from the net emission reductions.

Leakage shall be identified, assessed, monitored (where applicable), and deducted in accordance with the requirements of this methodology, and shall be transparently reported and verified in accordance with the BioCarbon MRV Tool v2.0.

13.2 Potential sources of leakage

The project holder shall evaluate at minimum the following potential leakage sources:

(a) Upstream manure diversion leakage

Leakage may occur if:

(i) Manure previously managed under controlled systems is diverted to the project;

(ii) Manure is relocated from other livestock operations that subsequently adopt higher-emission management practices.

The project shall demonstrate that:

(a) The manure treated under the project would otherwise have been managed under methane-emitting conditions;
(b) The project does not cause other facilities to adopt higher-emission manure management systems.

If manure is diverted from another facility, the project holder shall assess whether the original facility increases emissions as a result.

Where such displacement results in measurable emission increases, these emissions shall be quantified and deducted.

(b) Digestate management leakage

Leakage may occur if digestate produced by anaerobic digestion is:

(i) Stored under anaerobic conditions without methane capture;
(ii) Improperly managed, leading to methane or nitrous oxide emissions;
(iii) Disposed in a manner that increases emissions relative to baseline practice.

The project shall monitor digestate handling practices, including:

(i) Storage conditions;
(ii) Duration of storage;
(iii) Land application practices;
(iv) Presence or absence of methane capture during storage.

If digestate is stored under anaerobic conditions without capture, methane emissions shall be calculated using IPCC manure management emission factors and deducted from the project emission reductions.

If digestate is applied to land, nitrous oxide emissions shall be quantified in accordance with IPCC 2006 Guidelines and deducted were material.

(c) Induced livestock production leakage

The project shall assess whether implementation of biomethanisation:

(i) Indirectly increases livestock production;
(ii) Improves profitability in a manner that leads to expansion of herd size;

(iii) Causes measurable increases in manure generation beyond baseline trends.

If livestock population increases are directly attributable to the project activity and exceed sectoral or regional trends, associated methane and nitrous oxide emissions shall be quantified and deducted.

Normal market growth consistent with historical trends shall not be considered leakage.

Attribution shall be assessed against documented livestock population trends for at least three years prior to the project start date, unless justified otherwise.

(d) Energy substitution leakage

Where biogas is used to generate energy:

(i) The project shall ensure that fossil fuel consumption is actually displaced;
(ii) Double counting of energy-related benefits is avoided;
(iii) No secondary fossil fuel increases occur outside the project boundary as a result of energy reallocation.

If fossil fuel displacement is overestimated, corrections shall be applied conservatively.

(e) Transportation leakage

If implementation of the project causes:

(i) Increased transport distances for manure collection;
(ii) Transport of digestate beyond normal practice;
(iii) Additional fuel consumption attributable to the project,

these emissions shall be quantified using conservative fuel emission factors and deducted from net mitigation outcomes.

(f) Leakage significance threshold

Leakage shall be considered material in accordance with the materiality provisions of the BioCarbon MRV Tool.

Sources below this threshold may be excluded if justified and documented conservatively.

(g) Quantification of leakage

Leakage emissions shall be calculated using:

(i) IPCC 2006 emission factors for methane and nitrous oxide;

(ii) National inventory factors, where available and transparent;
(iii) Conservative assumptions where uncertainty exists.

Where activity data are uncertain, the BioCarbon Uncertainty Tool v1.0 shall be applied

If the relative half-width of the 90% confidence interval exceeds 30%, the excess uncertainty shall be deducted from the net mitigation outcome prior to issuance.

(h) Ex-post monitoring of leakage

Leakage shall be monitored during each verification event in accordance with the BioCarbon MRV Tool v2.0

Monitoring shall include:

(i) Verification of manure sourcing;
(ii) Confirmation of digestate management practices;
(iii) Assessment of livestock population trends;
(iv) Review of transport data.

Leakage emissions shall be reported transparently in the monitoring report and deducted prior to credit issuance.

(i) Conservative deduction

All quantified leakage emissions shall be deducted from the total project emission reductions prior to:

(i) Uncertainty adjustment (if applicable);
(ii) Rounding of Verified Carbon Credits (VCCs).

Final VCC issuance shall reflect:

Net Emission Reductions = Project methane avoided – Project emissions – Leakage emissions – Uncertainty deduction

Rounded down to the nearest whole ton of CO_2e in accordance with MRV requirements.

(j) Documentation requirements

The project holder shall document:

(i) All identified leakage sources;
(ii) Justification for inclusion or exclusion;

(iii) Quantification methods and emission factors;
(iv) Supporting data and calculations;
(v) Monitoring evidence.

Failure to adequately assess or deduct material leakage may result in:

(i) Reduction of issued credits;
(ii) Suspension of issuance;
(iii) Corrective action requirements.

14 Uncertainty assessment and conservative adjustment

14.1 General requirements

The project activity shall identify, quantify, and conservatively manage uncertainty associated with the estimation of greenhouse gas (GHG) emission reductions.

Uncertainty management shall be conducted in full compliance with the BioCarbon Uncertainty Management Tool v1.0

All emission reduction estimates shall:

(a) Be based on conservative assumptions;
(b) Apply transparent and reproducible calculations;
(c) Quantify uncertainty at the 90% confidence level;
(d) Apply conservative deductions where required.

14.2 Sources of uncertainty

The project holder shall identify and document all relevant sources of uncertainty, including but not limited to:

(a) Methane generation potential of manure;
(b) Methane conversion factors (MCF);
(c) Methane content of biogas;
(d) Biogas flow measurements;
(e) Combustion efficiency;
(f) Livestock population data;
(g) Digestate emission factors;
(h) Transport fuel consumption (if applicable).

Uncertainty shall be assessed for:

(a) Emission factors;
(b) Activity data;
(c) Monitoring equipment;
(d) Modelling assumptions.

14.3 Quantification approach

Uncertainty shall be quantified using either:

Tier 1 – Error propagation method

or

Tier 2 – Probabilistic (Monte Carlo) approach

as defined in the BioCarbon Uncertainty Management Tool.

The Tier 1 method shall apply:

- Rule A for addition of uncertain quantities;
- Rule B for multiplication of uncertain quantities.

The combined uncertainty shall be expressed as the relative half-width of the two-sided 90% confidence interval.

14.4 Threshold for conservative adjustment

The project holder shall calculate the total uncertainty associated with net emission reductions.

If the relative half-width of the 90% confidence interval exceeds 30%, the excess percentage shall be deducted from the net GHG emission reductions, in accordance with Section 11.2 of the BioCarbon Uncertainty Tool

Example:

If total uncertainty = 38%,

Conservative deduction = (38% – 30%) = 8% of net emission reductions.

The deduction shall be applied before rounding and issuance of Verified Carbon Credits (VCCs).

14.5 Exemption based on national consistency

If emission factors, activity data, and baseline projections are demonstrably consistent with the national GHG inventory and official reference scenario, and this consistency is fully documented, the conservative adjustment defined in Section 13.4 may be waived, in accordance with the BioCarbon Uncertainty Tool.

Such consistency shall be transparently documented and validated.

14.6 Rounding rule

After applying any required uncertainty deduction, the final quantity of Verified Carbon Credits (VCCs) shall be rounded down to the nearest whole metric ton of CO_2 equivalent, in accordance with the BioCarbon MRV Tool v2.0.

14.7 Documentation and reporting

The project holder shall include in each monitoring report:

(a) Identification of uncertain parameters;
(b) Description of the uncertainty quantification method applied (Tier 1 or Tier 2);
(c) Calculation of the combined uncertainty;
(d) Conservative deduction applied (if any);
(e) Final adjusted emission reductions prior to rounding.

Supporting spreadsheets and calculation files shall be made available for independent verification.

14.8 Continuous improvement

Uncertainty estimates shall be reassessed at each verification event and updated when:

(a) New monitoring data become available;
(b) Measurement systems are upgraded;
(c) Improved emission factors are published;
(d) Significant deviations are identified.

15 Monitoring requirements

15.1 Data and parameters not monitored

In addition to the parameters listed in Annex 8, this methodology also applies to data and parameters not monitored in the tools.

15.2 Monitoring plan

Project holders shall submit a monitoring plan in accordance with the standard and additionally describe the procedures for monitoring project activities and GHG emission reductions within the project boundary.

The GHG Project holder shall demonstrate that emission reductions are quantified, monitored, reported and verified, through the application of the BCR Tool "Monitoring, reporting and verification (MRV)"[16].

To ensure that the animal manure entering the central treatment plant are indeed originated from the sites included in the project boundary, it must be ensured that:

1) In the case where residues are collected with tank trucks, the precise location of manure collection points shall be identified in the project document (e.g., coordinates using global positioning system) and the road distances of the itineraries between them and the manure central treatment plant shall be documented using information from official sources. CABs shall validate this information and the origin of animal manure during the site visit.

2) In the cases where residues are led to the central treatment plant though pipes, the piping system shall be detailed in the project document. The quantity of residues collected through the pipes system shall be measured (m^3). It shall be depicted in the project document whether the residues are continuously directed to the central treatment plant or not.

3) CABs shall perform site visits on the central treatment plant during project validation and verification. All documentation which shall be checked by the CAB, referring to every farm, must be available during the validation and verification (sales records, feed formulation, etc.). However, CABs are not requested to perform site visits in all farms included in the project boundary. Instead, the CABs and project holders may proceed as described in the following section.

4) Prior to the validation and verification, project holders shall calculate the baseline emission from each site separately. Then, project holders shall ordinate, in decreasing order, the sites where most of the baseline emissions would occur. CAB shall prioritize physical site visits for farms representing material baseline emission sources, defined as those contributing individually or cumulatively to at least 20% of total baseline emissions or exceeding a materiality threshold defined in the BioCarbon MRV framework. This guarantees that the most preponderant baseline

[16] https://biocarbonstandard.com/wp-content/uploads/BCR_Monitoring-reporting-and-verification.pdf

GHG sources are properly validated and/or verified. For the remaining sites ("lower rank"), CABs shall perform site visits on a number n of randomly selected sites, being n determined as:

$$n = \frac{N}{1 + NE^2}$$ **Equation 43**

Where:

n = Number of "lower rank" sites to be visited by CAB

N = Total number of "lower rank" sites

E = The sampling error shall be defined by the CAB in accordance with the BioCarbon MRV Tool and the Uncertainty Management Tool, ensuring consistency with the 90% confidence level requirement.

Then, a CH4 emission reduction deviation factor (DF_{site}) shall be calculated for each "lower rank" site.

$$DF_{site} = \frac{BE_{site}^{obs}}{BE_{site}^{claimed}}$$ **Equation 44**

Where:

DF_{site} = Deviation factor for the "lower rank" sites visited by the CAB (dimensionless)

BE_{site}^{obs} = Baseline emissions verified by CAB after site inspection (tCO_2e)

$BE_{site}^{claimed}$ = Baseline emissions claimed by project holders for a given "lower rank" site (tCO_2e)

The largest value DF_{site} can assume is 1.

Then, an average baseline emissions deviation factor ($\overline{DF}$) shall be calculated:

$$\overline{DF} = \frac{\sum_{site}\left(DF_{site} \times BE_{site}^{obs}\right)}{\sum_{site} BE_{site}^{obs}}$$ **Equation 45**

Where:

$\overline{DF}$ = Average deviation factor for the "lower rank" sites visited by the CAB (dimensionless);

DF_{site} = Deviation factor for the "lower rank" sites visited by the CAB (dimensionless);

BE_{site}^{obs} = Baseline emissions verified by CAB after "lower rank" sites inspection (tCO_2e)

Then, the baseline emissions from the "lower rank" sites shall be corrected as follows:

$$BE_{LR,total}^{corrected} = \overline{DF} \times \sum_{site} BE_{site}^{claimed}$$ **Equation 46**

Where:

$BE_{LR,total}^{corrected}$ = Total corrected baseline emissions from the "lower rank" sites (tCO_2e)

$\overline{DF}$ = Deviation factor for the "lower rank" sites visited by the CAB (dimensionless)

$BE_{site}^{claimed}$ = Baseline emissions claimed by project holders for a given "lower rank" site (tCO_2e)

Then, total baseline emissions shall be calculated as follows:

$$BE_{total} = BE_{LR,total}^{corrected} + BE_{UR,total}$$ **Equation 47**

Where:

BE_{total} = Total baseline emissions (tCO_2e)

$BE_{LR,total}^{corrected}$ = Total corrected baseline emissions from "lower rank" sites (tCO_2e)

$BE_{UR,total}$	=	Total baseline emissions from "upper rank" sites (tCO_2e) (no correction values shall be applied – absolute verified values must be used)

For the lower rank farms that have not been visited a virtual inspection shall be performed by the CAB.

During the site visits, for both validation and verification site visits, CAB shall participate in a meeting with the stakeholders to assess the application of the project activity and its impact on the environment.

Options for site visit:

(a) The physical site visit of project site and all farms included in the project boundary is mandatory for validation.

(b) Any alterations in animal manure supplier farms, including the addition of new suppliers or the exclusion of current ones, must be thoroughly justified and reported in the project document. CAB shall assess and validate the eligibility of the new animal manure supplier farms to baseline scenario by physical site visit.

(c) For crediting renewal period that physical site visit of animal manure supplier farms is not mandatory, CAB can choose to conduct site visits remotely, the following three criteria are met:

   (i) In case a physical site visit is not possible for any of the farms within the project boundary, except the new animal manure supplier farms,

   (ii) The feasibility of remote audits of the farms,

   (iii) The appropriateness of the use of remote audit technique.

(d) The number of farms that can be visited remotely shall be determined by CAB in accordance with the BioCarbon MRV Tool and applicable ISO auditing standards.

This approach involves leveraging advanced information and communication technology (ICT) to collect pertinent information, conduct interviews with farm owners, and adhere to the established guidelines of the ISO 19011 standard. CAB shall collect key evidence with ICT that supports the scope of the assessment. The integration of suitable technology for remote audit techniques includes handheld devices, laptops, desktop computers, smartphones, drones, video cameras, and more. These tools are employed to collect, store, retrieve, process, analyse, and transmit information for auditing and assessments, both locally and remotely. The reason for the remote site visit shall be described in the validation or verification report as the alternative means used and justify that they are credible and sufficient for validation or verification.

15.3 Monitoring procedure

The monitoring plan for the project activity shall be described in the project document. The key elements of the monitoring plan are:

(a) Monitored parameters and method to monitor/record,

(b) Monitoring equipment,

(c) Quality Control/Quality Assurance (QA/QC) procedures (Staff trainings, procedure in case of failure of the monitoring equipment, emergency preparedness and more),

(d) Sampling plan,

(e) Organizational scheme of the project activity and responsibilities to ensure the real, reliable, and traceable measurement of the GHG emission reductions, which shall be validated by CAB.

For each monitored parameter, monitoring equipment, a description of the method to monitor/record, and be responsible shall be illustrated transparently and completely, as shown in Table 2.

Table 2. Description of monitoring plan

Monitored Parameter	Monitoring Equipment	Description of Method to Monitor/Record	Responsible

The monitoring equipment will undergo maintenance/calibration subject to appropriate industry standards and/or regional/national standards. This maintenance/calibration practice shall be clearly stated in the project document.

15.4 Data and parameters monitored

Data and parameters that shall be monitored as indicated Annex 9. Any additional monitoring parameter related to utilized methodological tools shall be clearly provided in the project document in accordance the following reporting structure.

16 Version, Validity and Applicability

16.1 Status of this document

This document constitutes Version 2.0 – Public Consultation Draft of the BCR0008: Biomethanisation Plants – Animal Manure Management for Renewable Energy, Heat Generation, and Methane Mitigation.

This version is released for public consultation and stakeholder review. During this period, feedback from technical experts, project holders, Conformity Assessment Bodies (CABs), regulators, and market participants may be submitted to BioCarbon Cert for consideration.

This version is not final and may be revised before formal approval and entry into force.

16.2 Version

Version 2.0 – Public Consultation, February 19, 2026

This version supersedes Version 1.0 of BCR0008 for the purposes of public consultation only.

Upon final approval, Version 2.0 shall replace all prior versions of this methodology.

16.3 Scope of revisions introduced in Version 2.0

Version 2.0 introduces structural and substantive updates, including but not limited to:

(a) Full alignment with the BioCarbon Additionality Tool v1.0;
(b) Integration of the BioCarbon Uncertainty Management Tool v1.0;
(c) Alignment with the BioCarbon MRV Tool v2.0 ;
(d) Strengthened baseline identification and additionality procedures;
(e) Formalized leakage identification, quantification, and deduction requirements;
(f) Clarified treatment of uncertainty and conservative adjustments;
(g) Improved structural coherence and alignment with high-integrity crediting principles.

These revisions aim to ensure full compliance with internationally recognized standards of environmental integrity and carbon credit quality.

16.4 Entry into force

Following the public consultation process and approval by the BioCarbon Technical Committee, Version 2.0 shall enter into force on the date of its formal publication.

The entry-into-force date shall be specified in the final approved version.

From that date onward, Version 2.0 shall be mandatory for all:

(a) New project registrations;
(b) Validation processes initiated after the entry-into-force date;
(c) Verification events covering monitoring periods commencing after the entry-into-force date.

16.5 Applicability to existing projects

The applicability of Version 2.0 to projects already registered under Version 1.0 shall be governed by the following provisions:

16.6 Projects not yet validated

Projects that have not submitted a complete validation report to BioCarbon prior to the entry-into-force date of Version 2.0 shall apply Version 2.0 in full.

16.7 Projects under validation

Projects undergoing validation at the time of entry into force may:

(a) Continue under Version 1.0 if the site visit has already been conducted prior to the entry-into-force date; or
(b) Elect to transition to Version 2.0 voluntarily.

Such transition shall be applied consistently to the entire validation process.

16.8 Registered projects

Projects already registered under Version 1.0:

(a) May continue applying Version 1.0 until the end of their current quantification period;
(b) Shall apply Version 2.0 at the time of quantification period renewal; or

(c) May voluntarily adopt Version 2.0 earlier, subject to validation of methodological consistency.

16.9 Retroactivity

Updates introduced in Version 2.0 shall not apply retroactively to monitoring periods that have already been verified and for which Verified Carbon Credits (VCCs) have been issued.

However, if material non-conformities are identified that affect environmental integrity, BioCarbon reserves the right to apply corrective measures in accordance with the Standard Operating Procedures.

16.10 Version control and updates

BioCarbon Cert may periodically update this methodology to:

(a) Incorporate scientific or technical improvements;
(b) Align with updates to BioCarbon program-level tools;
(c) Address stakeholder feedback;
(d) Strengthen environmental integrity.

Each new version shall:

(a) Clearly state the nature of changes introduced;
(b) Specify its entry-into-force date;
(c) Include transition provisions where applicable;
(d) Maintain public traceability through version history documentation.

Project holders and Conformity Assessment Bodies (CABs) shall ensure that the applicable version in force at the time of validation or verification is correctly applied.

Annex 1: Anaerobic Unit Process Performance

Table 8-10. Anaerobic Unit Process Performance

Anaerobic Treatment	HRT	COD	TS	VS	TN	P	K
	days	Percent Reduction					
Pull plug pits	4-30	—	0-30	0-30	0-20	0-20	0-15
Underfloor pit storage	30-180	—	30-40	20-30	5-20	5-15	5-15
Open top tank	30-180	—	—	—	25-30	10-20	10-20
Open pond	30-180	—	—	—	70-80	50-65	40-50
Heated digester effluent prior to storage	12-20	35-70	25-50	40-70	0	0	0
Covered first cell of two cell lagoon	30-90	70-90	75-95	80-90	25-35	50-80	30-50
One-cell lagoon	>365	70-90	75-95	75-85	60-80	50-70	30-50
Two-cell lagoon	210+	90-95	80-95	90-98	50-80	85-90	30-50
HRT=hydraulic retention time; COD=chemical oxygen demand; TS=total solids; VS=volatile solids; TN=total nitrogen; P=phosphorus; K= potassium; — =data not available.							

Source: Moser and Martin, 1999

Annex 2: Method for determination of Volatile Solid in animal waste

From: USDA. Agricultural Waste Management Field Handbook. Chapter 4 - Agricultural Waste

Characteristics. Page 2.

Definitions

- Total Solids: Residue remaining after water is removed from waste material by evaporation; dry matter;
- Volatile Solids: The part of total solids driven off as volatile (combustible) gases when heated to 600ºC; organic matter;
- Fixed Solids: The part of total solids remaining after volatile gases driven off at 600ºC; ashes.

Determination method

1. Evaporate free water on steam able and dry in oven at 103°C for 24 hours or until constant weight to obtain the Total Solids.
2. Place Total Solids residue in furnace at 600ºC for at least 1 hour. Volatile Solids are determined from weight difference of total and Fixed Solids.

Equation 48

$$Volatilematter(drybasis) = \frac{W_2 - W_f}{W_2 - W_1}$$

Where W1 is the weight of sample container, W2 is combined weight of the sample container and oven dried sample, Wf is the combined constant weight of the sample container and sample after heating at 600ºC

Annex 3: Determination of Total Nitrogen in animal waste

Definitions

- Ammoniacal nitrogen (total ammonia): Both NH_3 and NH_4 nitrogen compounds;
- Ammonia nitrogen: A gaseous form of ammoniacal nitrogen;
- Ammonium nitrogen: The positively ionized (cation) form of ammoniacal nitrogen;
- Total Kjeldahl nitrogen: The sum of organic nitrogen and ammoniacal nitrogen;
- Nitrate nitrogen: The negatively ionized (anion) form of nitrogen that is highly mobile;
- Total nitrogen: The summation of nitrogen from all the various nitrogen compounds listed above.

Principles and guidelines for Total Nitrogen Determination:

Total Kjeldahl nitrogen (TKN) can be an accurate predictor of total N content, because the inorganic N content in manure generally is very small when compared to the total N content (Paul and Beauchamp, 1993; Eghball, 2000).

Total Kjeldahl nitrogen is a wet oxidation procedure used to determine the organic N present as NH_3 in soils, plants and organic residues, such as manure. The three main steps of the Kjeldahl method are: (1) digestion, (2) separation of ammonia, and (3) determination of ammonia. In some techniques the separation stage is omitted and the ammonia is determined directly on the digest. Separation of ammonia may be effected by steam distillation, aeration, or diffusion, steam distillation being conventional. With automated procedures this separation step is invariably omitted (Fleck, 1969).

The determination of ammonia may be by: (1) simple titration, (2) iodometric methods, (3) coulometric methods or (4) colorimetric methods. Without separation of ammonia from the digest simple titration cannot be utilized (Fleck, 1969).

The remaining three techniques can, however, be applied directly to the digest. Iodometric and analogous methods have disadvantages (McKenzie & Wallace, 1954 APUD Fleck, 1969) and are not popular. Coulometric methods are not widely applied. Colorimetry remains as the only well-tried approach for automation (Fleck, 1969).

The three popular colorimetric methods of NH_3, determination are: ninhydrin, Nessler, and the phenol-hypochlorite or Berthelot reaction. The ninhydrin method has been successfully applied following sealed-tube digestion (Jacobs, 1965 APUD Fleck, 1969). The Nessler method, although excellent for simple aqueous ammonia solutions, is not advisable when ammonia is to be determined in Kjeldahl digestion mixtures (Fleck & Munro, 1965 APUD Fleck, 1969).

The most important aspect of the Kjeldahl method is digestion, which may be carried out in an open tube or in a sealed tube. The critical factors are: (I) temperature, (2)catalyst, (3) time, (4) reflux and (5) decomposition of the ammonia-catalyst complex. The optimum temperature for sealed-tube digestion is in the region of 450ºC and the main advantage is that no catalyst or other additions are required.

The more commonly utilized open-tube digestion requires a temperature close to 400°C for adequate decomposition of nitrogenous compounds to ammonia. The evidence for this is clear (Bradstreet, 1965; Fleck & Munro, 1965 APUD Fleck, 1969), as is the evidence that the only satisfactory means of attaining this temperature is to add the appropriate amounts of K_2SO_4. When the temperature exceeds 400°C the digest solidifies on cooling (Bradstreet, 1957 APUD Fleck, 1969). This is an important practical point because temperatures in excess of 400ºC lead to loss of nitrogen (as well as loss of acid which leads to the solid cold digest).

With regard to the catalyst, mercury is indicated as the only 'safe' catalyst, with which no losses have been reported (Bradstreet, 1965; Fleck & Munro, 1965APUD Fleck, 1969). The disadvantage of mercury is that it forms a mercury-ammonium complex which must be decomposed before determining ammonia. This decomposition may be achieved by using sodium thiosulphate or zinc dust (Fleck, 1969).

The use of oxidizing can cause loss of nitrogen (Peters & Van Slyke, 1932). There the use of such agents is not recommended for the purposes of the project activities employing this methodology.

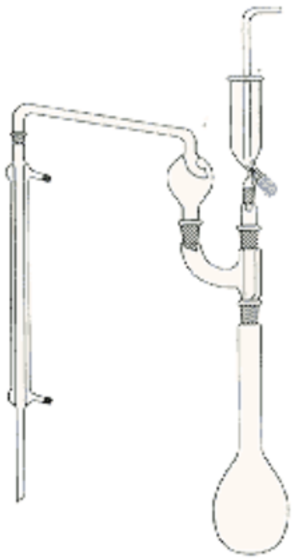
For manual determination PPs shall follow the protocol depicted below (adapted from Mendham et al., 2002):

1. Homogenize manure sample through intense agitation;
2. Before sample precipitates pipette a certain volume (*a* mL) which contains approximately 0.04 g of nitrogen (based on previous experience) and transfer it to a long-necked Kjeldahl digestion tube;
3. Add 0.7 g mercury oxide (II), 15 gof potassium sulfate and 40 mL of concentrated sulfuric acid;
4. Gently heat the digestion tube, keeping it slightly tilted. Frothing may occur. If needed frothing may be controlled through the use of anti-frothing agents;
5. Once frothing ceases, boil reagents during 2 hours;
6. After cooling add 200 mL of water and 25 mL of sodium thiosulphate solution (0.5 M). Perform this step under agitation;
7. Add a few glass beads to the mixture;
8. Carefully introduce in the digestion tube a sodium hydroxide solution (11 M). Before mixing the reagents, connect the digestion tube to a distillation apparatus (see figure below). Keep the outlet of the condenser immersed into a known volume of 0.1 M HCl solution. Be certain that the contents of the digestion tube are well mixed;
9. Boil until the 150 mL of the distilled liquid has been collected in the receptor tube;
10. Add indicator Methyl Red to the receptor tube. Titrate with 0.1 M NaCl (*b* mL). Titrate a blank using the same volume of 0.1 M HCl (*c* mL).

With the quantities and concentrations of reagents provided above, the nitrogen concentration in the sample (kg N/m^3) is given as follows:

Equation 49

$$[N] = \frac{(c - b) \cdot 0.1 \cdot 14}{a} \cdot 10^3$$



Assembly of the Kjeldahl apparatus.

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USDA. Agricultural Waste Management Field Handbook. Chapter 4 - Agricultural Waste Characteristics. Page 2.

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Annex 4: Guidance on sample extraction procedures

For the purposes of the essays described in Annex 2 and 3, project holders shall observe the following guidance on sample extraction procedure:

1. For liquid material, samples shall be preferably collected using continuous-flow samples at the entrance or exit point of the pertinent treatment stage;
2. Samples shall be collected in clean wide-mouth glass bottles;
3. Samples shall be analysed as soon as possible. If samples need to be stored, storage shall be performed at 4ºC;
4. It shall be checked that the suspended matter does not adhere to the walls, prior to the analysis procedure;
5. If results must be expressed in a dry matter basis, dry matter content shall be determined after oven-drying at 103°C for 24 hours or until constant weight is obtained;
6. Uncertainty shall be quantified at a two-sided 90% confidence interval using the following statistical expression:

$$\bar{x} \pm \frac{t \cdot s}{\sqrt{n}}$$ **Equation 50**

Where:

$\bar{x}$	Sample average;
t	t student value for n– − 1 (v) degrees of freedom (see table 3);
s	Sample standard deviation;
n	Number of samples.

The resulting relative uncertainty shall be incorporated into the overall project uncertainty assessment in accordance with the BioCarbon Uncertainty Management Tool v1.0.

No fixed maximum uncertainty threshold shall apply at the parameter level; conservativeness adjustments shall be applied only at the net emission reduction level as defined in the BioCarbon Uncertainty Tool.

Table 3. Values for t-distributions with v degrees of freedom for a range of one-sided confidence intervals.											
v	**75%**	**80%**	**85%**	**90%**	**95%**	**97.5%**	**99%**	**99.5%**	**99.75%**	**99.9%**	**99.95%**
1	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	127.3	318.3	636.6
2	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	14.09	22.33	31.60
3	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
50	0.679	0.849	1.047	1.299	1.676	2.009	2.403	2.678	2.937	3.261	3.496
60	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
80	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	2.887	3.195	3.416
100	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	2.871	3.174	3.390
120	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Annex 5: Table 10.17 from 2019 Refinement to IPCC 2006

TABLE 10.17 (UPDATED)
METHANE CONVERSION FACTORS FOR MANURE MANAGEMENT SYSTEMS

System[4]		MCFs by climate zone									
		Cool				Temperate		Warm			
		Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Uncovered anaerobic lagoon[7]		60%	67%	50%	49%	73%	76%	76%	80%	80%	80%
Liquid/Slurry, and Pit storage below animal confinements[1]	1 Month	6%	8%	4%	4%	13%	15%	25%	38%	36%	42%
	3 Month[8]	12%	16%	8%	8%	24%	28%	43%	61%	57%	62%
	4 Month[9]	15%	19%	9%	9%	29%	32%	50%	67%	64%	68%
	6 Month[9]	21%	26%	14%	14%	37%	41%	59%	76%	73%	74%
	12 Month[9]	31%	42%	21%	20%	55%	64%	73%	80%	80%	80%
Cattle and Swine deep bedding[5]	> 1 month[10]	21%	26%	14%	14%	37%	41%	59%	76%	73%	74%
	< 1 month[11]	2.75%				6.50%		18%			
Solid storage[6,12]		2.00%				4.00%		5.00%			
Solid storage – Covered/compacted[6,13]		2.00%				4.00%		5.00%			
Solid storage – Bulking agent addition[6,14]		0.50%				1.00%		1.50%			
Solid storage – Additives[6,15]		1.00%				2.00%		2.50%			
Dry lot[16]		1.00%				1.50%		2.00%			
Daily spread[17]		0.10%				0.50%		1.00%			
Composting - In-vessel[4,18]		0.50%									
Composting - Static pile (Forced aeration)[4,6,19]		1.00%				2.00%		2.50%			
Composting - Intensive windrow[4,20]		0.50%				1.00%		1.5%			
Composting – Passive windrow (Unfrequent turning)[3,4,6,21]		1.00%				2.00%		2.50%			

TABLE 10.17 (UPDATED) (CONTINUED)
METHANE CONVERSION FACTORS FOR MANURE MANAGEMENT SYSTEMS

System[4]	MCFs by climate zone									
	Cool				Temperate		Warm			
	Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Pasture/Range/Paddock[2]	0.47%									
Poultry manure with and without litter[22]	1.50%									
Aerobic treatment[23]	0.00%									
Burned for fuel[24]	10.00%									
Anaerobic Digester[25], Low leakage, High quality gastight storage, best complete industrial technology	1.00%									
Anaerobic Digester[25], Low leakage, High quality industrial technology, low quality gastight storage technology	1.41%									
Anaerobic Digester[25], Low leakage, High quality industrial technology, open storage	3.55%				4.38%		4.59%			
Anaerobic Digester[25], High leakage, low quality technology, high quality gastight storage technology	9.59%									
Anaerobic Digester[25], High leakage, low quality technology, low quality gastight storage technology	10.00%									
Anaerobic Digester[25], High leakage, low quality technology, open storage	12.14%				12.97%		13.17%			

Annex 6: Procedure for estimating NEX

$$\boldsymbol{NEX = N_{intake} \cdot (1 - N_{retention})}$$ **Equation 51**

Where:

N_{intake}	=	The annual N intake per animal – kg N/animal-year
$N_{retention}$	=	The portion of that N intake that is retained in the animal (default values are reported in Table 10.20 in IPCC 2006 guidelines, volume 4, chapter 10).

N_{intake} may be calculated using:

$$N_{intake} = \left(\frac{GE}{18.45}\right) \cdot \left(\frac{CP \cdot 0.01}{6.25}\right)$$ **Equation 52**

Where:

CP	=	Crude percent of protein (percent)
GE	=	Gross energy intake of the animal, in enteric model, based on digestible energy, milk production, pregnancy, current weight, mature weight, rate of weight gain, and IPCC constants, MJ/day
18.45	=	Conversion factor for dietary GE per kg of dry matter (MJ/kg). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock
6.25	=	Conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg N)-1

In absence of availability of project specific information on Protein intake, which shall be justified in the project document, site-specific national or regional data shall be used for the nitrogen excretion NEX, if available.

In the absence of national data, default values from table 10.19 (updated) of the 2019 Refinement to IPCC 2006, volume 4, chapter10) may be used and shall be corrected for the animal weight at the project site in the following way:

$$NEX_{site} = \frac{W_{site}}{1000} \cdot NEX_{IPCC,default}$$ **Equation 53**

Where:

NEX_{site}	=	Is the adjusted annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year
W_{site}	=	Is the average animal weight of a defined population at the project site in kg
$NEX_{IPCC,default}$	=	Is the default value (IPCC 2006 or US-EPA 2002) for the nitrogen excretion per head of a defined livestock population in kg N/animal/year

Annex 7: Default values for simplified estimation of CH_4 emissions from co-digested organic waste.

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
1	0.005800	0.001856	0.003382	0.001399
2	0.004212	0.001724	0.002913	0.001325
3	0.003093	0.001601	0.002511	0.001254
4	0.002275	0.001487	0.002163	0.001188
5	0.001657	0.001381	0.001861	0.001125
6	0.001198	0.001281	0.001599	0.001065
7	0.000867	0.001189	0.001371	0.001008

x	Tropical wet	Tropical dry	Boreal/ temperate wet	Boreal/temperate dry
8	0.000635	0.001103	0.001174	0.000954
9	0.000474	0.001024	0.001004	0.000904
10	0.000362	0.000950	0.000859	0.000855
11	0.000284	0.000881	0.000734	0.000810
12	0.000228	0.000817	0.000629	0.000766
13	0.000189	0.000757	0.000539	0.000725
14	0.000160	0.000702	0.000463	0.000687
15	0.000138	0.000651	0.000399	0.000650
16	0.000122	0.000603	0.000344	0.000615
17	0.000109	0.000559	0.000298	0.000582
18	0.000098	0.000518	0.000259	0.000551
19	0.000090	0.000480	0.000226	0.000521
20	0.000082	0.000445	0.000197	0.000493
21	0.000076	0.000413	0.000173	0.000467

Annex 8: Data and parameters not monitored

Data / Parameter Table 1

Parameter:	$R_{VS,n}$
Data unit:	Fraction
Description:	Relative reduction of volatile solids from the previous stage
Source of data:	Refer to Annex 1.
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	Estimated from Table provided in Annex 1. The most conservative value for the given technology must be used.

Data / Parameter Table 2

Parameter:	EFN2O,ID
Data unit:	kg N2O-N/ kg NH3-N and NOx-N
Description:	Indirect N2O emission factors
Source of data:	2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Table 11.3 (Updated), Volume 4, Chapter 11
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values may be used, if country specific or region-specific data are not available. In the case of utilizing IPCC default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 3

Parameter:	Fgasm
Data unit:	Fraction
Description:	Percent of total nitrogen that volatilises as NH3 and NOx in the treatment stage j
Source of data:	2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Table 11.3 (Updated), Volume 4, Chapter 11
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values may be used if country specific or region-specific data are not available. In the case of utilizing IPCC default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 4

Parameter:	EF1, EF4 and EF5
Data unit:	kg N2O-N/ kg N for EF1and EF5; kg N2O-N/ kg NH3-N and NOx-N for EF4
Description:	N2O emission factor from soil and runoff water
Source of data:	2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Table 11.26 (Updated) and Table 11.3, Volume 4, Chapter 11
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values may be used if country specific or region-specific data are not available. In the case of utilizing IPCC default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 5

Parameter:	Fleach
Data unit:	Fraction
Description:	Fraction of N leached
Source of data:	2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Table 11.3 (Updated), Volume 4, Chapter 11
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values can be used. In the case of utilizing IPCC default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 6

Parameter:	EGBl,y
Data unit:	MWh
Description:	Electricity consumption by Baseline AWMSs
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically for the duration of project plus 5 years
Any comment:	Estimation is based on an average of the historical 3 years consumption prior to start of the project. Electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers. This uncertainty to be included in a conservative manner while calculating VCCs and procedure for doing so shall be described in the project document.

Data / Parameter Table 7

Parameter:	HGBl,y
Data unit:	MJ
Description:	Heat used by baseline AWMSs
Source of data:	Project holders
Measurement procedures (if any):	Archive electronic for the duration of project plus 5 years
Any comment:	Estimation is based on an average of the historical 3 years consumption prior to start of the project. Fuel purchase records to be cross checked with estimates.

Data / Parameter Table 8

Parameter:	GWPCH4 and GWPN2O
Data unit:	Dimensionless
Description:	Global warming potential for CH4 and N2O, respectively.
Source of data:	IPCC Fifth Assessment Report, Chapter 8, Table 8.A.1
Measurement procedures (if any):	Non Applicable. Global Warming Potentials (GWP) for CH_4 and N_2O shall be those formally adopted by the BioCarbon Standard in force at the time of validation or verification and shall be documented in the Monitoring Report.
Any comment:	---

Data / Parameter Table 9

Parameter:	$\rho_{CH4,n}$
Data unit:	t/m3

Description:	Density of methane at normal (at room temperature 20°C and 1 atm pressure) conditions
Source of data:	Established thermodynamic properties of methane at 20°C and 1 atm pressure. Value: 0.00067 t/m3.
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	6.7×10^{-4} t/m^3

Data / Parameter Table 10

Parameter:	MCFd
Data unit:	---
Description:	Methane conversion factor for leakage calculation assumed to be equal 1
Source of data:	See Leakage section
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	---

Data / Parameter Table 11

Parameter:	CFN2O-N,N
Data unit:	---
Description:	Conversion factor = 44/28
Source of data:	Stoichiometric molecular weight ratio (44/28)
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	---

Data / Parameter Table 12

Parameter:	ρf
Data unit:	t/m3
Description:	Density of fuel type f at normal conditions
Source of data:	Source of data shall be determined in the preference order below Values provided by the fuel supplier in invoices Regional or national default values
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	In the case of utilizing regional and national default values appropriateness of these values shall be assessed annually and most conservative value shall be used. This parameter may be utilized for the purpose of unit consistency.

Data / Parameter Table 13

Parameter:	MCFAer
Data unit:	---
Description:	Methane Conversion Factor (MCF) for aerobic system
Source of data:	2019 Refinement to IPCC 2006 Guidelines, Table 10.17.
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	---

Data / Parameter Table 14

Parameter:	MCFres
Data unit:	---

Description:	Methane Conversion Factor (MCF) for composting system
Source of data:	2019 Refinement to the 2006 IPCC Guidelines Table 10.17 (Updated), Volume 4 Chapter 10
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	In the case of utilizing IPCC default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 15

Parameter:	VSdefault
Data unit:	kg-VS-dm/1000 kg animal mass/day
Description:	Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock population
Source of data:	2019 Refinement to the 2006 IPCC Guidelines (IPCC 2019, as updated in July 2023), Table 10.13A (New), Chapter 10, Volume 4 or US-EPA 2002, whichever is lower
Measurement procedures (if any):	---
Any comment:	In the case of utilizing IPCC 2006 default values, latest refinement to IPCC Guidelines shall be taken into consideration in defining the default values to be applied.

Data / Parameter Table 16

Parameter:	EEj,y
Data unit:	%
Description:	Energy Conversion Efficiency of the project equipment j
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be determined via the specification provided by the equipment manufacture. The equipment shall be designed to utilize biogas as fuel, and the efficiency specification is for this fuel. If the specification provides a range of efficiency values, the most conservative value of the range shall be used for the calculation
Any comment:	---

Data / Parameter Table 17

Parameter:	k
Data unit:	Unitless
Description:	Degradation rate constant
Source of data:	Established manure degradation model parameters consistent with IPCC guidance.
Measurement procedures (if any):	Archive electronically during project plus 5 years
Any comment:	---

Data / Parameter Table 18

Parameter:	φdefault
Data unit:	Unitless
Description:	Default value for the model correction factor to account for model uncertainties. This correspond a conservative assumption.
Source of data:	T Conservative default value adopted under this methodology.
Value to be applied:	1
Measurement procedures (if any):	---

Any comment:	For the sake of conservativeness, the highest default value shall be applied.

Data / Parameter Table 19

Parameter:	fy
Data unit:	Unitless
Description:	Default value for the fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data:	AMS-III.AO: Methane recovery through controlled anaerobic digestion
Value to be applied:	For conservativeness, the fraction of methane captured in the baseline SWDS is assumed to be zero unless credible documented evidence demonstrates otherwise.
Measurement procedures (if any):	---
Any comment:	It is assumed that no biogas is captured, flared or used at the SWDS in the baseline scenario for the sake of conservativeness.

Data / Parameter Table 20

Parameter:	Default
Data unit:	Unitless
Description:	Default value for simplified estimation
Source of data:	Refer to Annex 7
Value to be applied:	---
Measurement procedures (if any):	---
Any comment:	Estimated from Table provided in Annex 7. 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.

Annex 9: Data and parameters monitored

Data / Parameter Table 21

Data / Parameter:	MCFj
Data unit:	Fraction
Description:	Methane Conversion Factor for the stage j of the baseline AWMS
Source of data:	2019 Refinement to IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, Table 10.17 (Updated)
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	The factor MCF shall be taken from 2019 Refinement to the 2006 IPCC Guidelines in accordance with the related climate zone for the project activity. Uncertainty associated with MCF values shall be treated in accordance with the BioCarbon Uncertainty Management Tool v1.0. No fixed conservativeness multiplier shall be applied.

Data / Parameter Table 22

Data / Parameter:	MCFl
Data unit:	Fraction
Description:	Annual methane conversion factor for the project manure storage tank l
Source of data:	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023) - Table 10.17, Chapter 10, Volume 4
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	

Data / Parameter Table 23

Data / Parameter:	Bo,LT
Data unit:	m3 CH4/kg VS dm
Description:	Maximum methane producing potential of the volatile solid generated
Source of data:	2019 Refinement to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, Table 10.16A (Updated) or directly measured
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	See guidance on how to estimate this parameter in the methodology. Values shall be consistent with the IPCC 2006 Guidelines and the 2019 Refinement, as adopted by the BioCarbon Standard.

Data / Parameter Table 24

Data / Parameter:	ndy
Data unit:	Number

Description:	Number of days the central treatment plant was operational in year y
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically for the duration of project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	The number of days that correspond to the months in which the average temperature is below 5°C shall be deducted from this parameter.

Data / Parameter Table 25

Data / Parameter:	QEM,Aer,m
Data unit:	m3/month
Description:	Monthly volume of the effluent entering the aerobic treatment step
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be monitored by using a flow meter/s Archive electronically during project plus 5 years
Monitoring frequency:	This parameter shall be continuously monitored
QA/QC procedures:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	---

Data / Parameter Table 26

Data / Parameter:	QEM,m
Data unit:	m3/month
Description:	Monthly volume of the feedstock entering the central treatment plant
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be monitored via flow meter/s installed just before anaerobic digesters. Archive electronically during project plus 5 years
Monitoring frequency:	This parameter shall be continuously monitored
QA/QC procedures:	Flow meters will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	---

Data / Parameter Table 27

Data / Parameter:	Qmanure,j,LT,wb,y
Data unit:	tonnes/year, wet basis
Description:	Quantity of manure treated from livestock type LT and animal manure management system j
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be directly monitored via weighbridge records for every manure acceptance. Alternatively, manure volume can be measured together with the density determined from representative sample (90/10 precision). Archive electronically during project plus 5 years
Monitoring frequency:	Annually, based on daily measurement and monthly aggregation
QA/QC procedures:	Weighbridge will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	This parameter shall be adjusted to dry basis for unit consistency

Data / Parameter Table 28

Data / Parameter:	Qmanure,j,LT,db,y
Data unit:	tonnes/year, wet basis
Description:	Quantity of manure treated from livestock type LT and animal manure management system j
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be adjusted to dry basis utilizing the following equation. $Q_{manure,j,LT,db,y} = Q_{manure,j,LT,wb,y} \times DM_{manure,LT}$
Monitoring frequency:	Annually, based on daily measurement and monthly aggregation
QA/QC procedures:	Weighbridge will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	---

Data / Parameter Table 29

Data / Parameter:	DMmanure,LT
Data unit:	Fraction
Description:	Dry matter content of manure from livestock type LT
Source of data:	Project holders
Measurement procedures (if any):	Source of data shall be determined via the options provided below Direct measurement at the project site Regional or national default values USDA. Agricultural Waste Management Field Handbook. Chapter 4 - Agricultural Waste Characteristics
Monitoring frequency:	Discontinuous daily measurement aggregated monthly
QA/QC procedures:	The related equipment for direct measurement will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	In the case of direct measurement dry matter content of animal manure for each manure supplier farm shall be measured separately. In the case of regional or national default values and default values taken from the USDA guidance, appropriateness of these values shall be assessed by the CAB.

Data / Parameter Table 30

Data / Parameter:	QDE,m
Data unit:	Tons of dry matter/month
Description:	Monthly quantity of treated effluent / residue disposed outside the project boundary
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be monitored via weighbridge data recorded for every batch disposed Archive electronically during project plus 5 years
Monitoring frequency:	Discontinuous daily measurement aggregated monthly
QA/QC procedures:	---
Any comment:	This parameter shall be adjusted to dry basis if needed for unit consistency

Data / Parameter Table 31

Data / Parameter:	DMDE,m
Data unit:	Fraction
Description:	Dry matter content of treated effluent disposed outside the project boundary

Source of data:	Project holders
Measurement procedures (if any):	Dry matter content of the disposed residue shall be monitored via sampling before the separator or after the combined line after the anaerobic digesters. Archive electronically during project plus 5 years
Monitoring frequency:	Discontinuous daily measurement aggregated monthly
QA/QC procedures:	The related equipment for direct measurement will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	---

Data / Parameter Table 32

Data / Parameter:	$Q^{in}_{Comp,m}$
Data unit:	Tons dry matter/month
Description:	Monthly quantity of residues entering the composting plant in a dry matter basis
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Discontinuous daily measurement aggregated monthly
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 33

Data / Parameter:	$Q^{out}_{Comp,m}$
Data unit:	Tons dry matter/month
Description:	Monthly quantity of produced compost in the project scenario
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Discontinuous daily measurement aggregated monthly
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 34

Data / Parameter:	VSres,m
Data unit:	Ton VS/ton residue
Description:	Average monthly volatile solids (VS) concentration of the residue entering the composting step
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Volatile solids determination shall be performed according to the guidance provided in Annex 2
Any comment:	---

Data / Parameter Table 35

Data / Parameter:	VSEM,Aer,m
Data unit:	Ton VS/m3
Description:	Average monthly volatile solids (VS) concentration of the effluent entering the aerobic treatment step
Source of data:	Project holders

Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Volatile solids determination shall be performed according to the guidance provided in Annex 2
Any comment:	---

Data / Parameter Table 36

Data / Parameter:	VSmanure,LT
Data unit:	kg-VS-dm per kg of dry manure
Description:	Average VS in the manure excreted by a defined population at the project site
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly, aggregated monthly and annually
QA/QC procedures:	Volatile solids determination shall be performed according to the guidance provided in Annex 2
Any comment:	---

Data / Parameter Table 37

Data / Parameter:	VSDE,m
Data unit:	Ton VS/ton of residue in dry basis
Description:	Monthly volatile solids concentration of the disposed effluent / residue
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Volatile solids determination shall be performed according to the guidance provided in Annex 2
Any comment:	---

Data / Parameter Table 38

Data / Parameter:	[N]EM,m
Data unit:	kg N/m3
Description:	Monthly total nitrogen concentration in the effluent mix entering the central treatment plant
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Sample collection procedures shall be performed as described in Annex 4. Total nitrogen determination shall be performed according to the guidance provided in annex 3
Any comment:	The effluent mix shall be collected after the effluent admittance point or after the equalization tanks (if existent)

Data / Parameter Table 39

Data / Parameter:	[N]DE,m
Data unit:	kg N/m3
Description:	Monthly total nitrogen concentration of the treated effluent / residue disposed outside the project boundary
Source of data:	Project holders

Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Every batch disposed
QA/QC procedures:	Total nitrogen determination shall be performed according to the guidance provided in Annex 3
Any comment:	---

Data / Parameter Table 40

Data / Parameter:	$\rho_{residue}$
Data unit:	kg/m^3
Description:	Density of the treated effluent mix disposed outside the project boundary
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Every batch disposed
QA/QC procedures:	---
Any comment:	This parameter shall be utilized to achieve unit conversion in the calculation of leakage project N_2O emissions.

Data / Parameter Table 41

Data / Parameter:	$[N]_{Comp,m}^{in}$
Data unit:	kg N/ton residue
Description:	Monthly total nitrogen concentration of the residues entering the composting plant
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Total nitrogen determination shall be performed according to the guidance provided in Annex 3
Any comment:	---

Data / Parameter Table 42

Data / Parameter:	$[N]_{Comp,m}^{out}$
Data unit:	kg N/ton residue
Description:	Monthly total nitrogen concentration of the residues leaving the composting plant
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	Total nitrogen determination shall be performed according to the guidance provided in Annex 3
Any comment:	---

Data / Parameter Table 43

Data / Parameter:	$CEF_{Bl,elec,y}$
Data unit:	tCO_2/MWh
Description:	Emission factor of baseline electricity use
Source of data:	Refer to baseline methodology

Measurement procedures (if any):	Relevant procedure adopted under the BioCarbon framework for determination of grid emission factors. Archive electronically during project plus 5 years
Monitoring frequency:	At start of project
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 44

Data / Parameter:	CEFgrid
Data unit:	tCO_2/MWh
Description:	Emission factor of exported electricity
Source of data:	Refer to baseline methodology
Measurement procedures (if any):	Relevant procedure adopted under the BioCarbon framework for determination of grid emission factors. Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 45

Data / Parameter:	CEFBl,therm,y
Data unit:	tCO_2/MJ
Description:	Emission factor for thermal energy
Source of data:	Refer to baseline methodology
Measurement procedures (if any):	Source of data shall be determined in the preference order below On-site measurement data Regional or national default values IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories Archive electronically during project plus 5 years
Monitoring frequency:	At the start of the project activity
QA/QC procedures:	---
Any comment:	If heat used is produced using biogas, the factor is zero

Data / Parameter Table 46

Data / Parameter:	EGd,y
Data unit:	MWh
Description:	Electricity exported to grid in a year y
Source of data:	Project holders
Measurement procedures (if any):	The receipts issued by the purchasing power company, that the produced electricity is sold, are the primary source for quantification of this parameter. Electricity meter readings shall be considered for crosscheck purposes. Archive electronically during project plus 5 years
Monitoring frequency:	Monthly, aggregated annually
QA/QC procedures:	Also, electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers. This uncertainty to be included in a conservative manner while calculating VCCs and procedure for doing so shall be described in the project document.

Any comment:	---

Data / Parameter Table 47

Data / Parameter:	CPi,y
Data unit:	MWh
Description:	Rated capacity of electrical equipment i
Source of data:	Project holders
Measurement procedures (if any):	The rated capacity of electrical equipment shall be determined based on the technical data sheet supplied by the manufacturing company Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	Any future changes of installed equipment shall be reported in the project document.

Data / Parameter Table 48

Data / Parameter:	BGutilized
Data unit:	m3
Description:	Volume of utilized biogas
Source of data:	Project holders
Measurement procedures (if any):	The amount of biogas recovered and utilized, flared or used gainfully shall be monitored ex post, using flow meters. If the biogas flared and or utilized is continuously monitored separately, the two fractions can be added to determine the biogas recovered. In that case, recovered biogas need not be monitored separately. The system shall be built and operated to ensure that there is no air ingress into the biogas pipeline. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place, and on the same basis (wet or dry) Archive electronically during project plus 5 years
Monitoring frequency:	Annually, based on continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 49

Data / Parameter:	HGy
Data unit:	MJ
Description:	Heat generated using biogas
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be measured from the heat received by the heated process. Alternatively, this parameter shall be determined as the difference of the enthalpy of the heat (steam or hot water) generated by the heat generators(s) minus the enthalpy of the feedwater, the boiler blow-down and any condensate return. The respective enthalpies shall be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. Archive electronically during project plus 5 years
Monitoring frequency:	Monthly, aggregated annually
QA/QC procedures:	---
Any comment:	---

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Data / Parameter Table 50

Data / Parameter:	EGy
Data unit:	MWh
Description:	Electricity generated using biogas
Source of data:	Project holders
Measurement procedures (if any):	This parameter shall be monitored via electricity meter/s Archive electronically during project plus 5 years
Monitoring frequency:	Monthly, aggregated annually
QA/QC procedures:	Electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers. This uncertainty to be included in a conservative manner while calculating VCCs and procedure for doing so shall be described in the project document.
Any comment:	---

Data / Parameter Table 51

Data / Parameter:	RN,n
Data unit:	Fraction
Description:	Nitrogen degradation factor
Source of data:	Project holders or Annex 1
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly
QA/QC procedures:	If no appropriate default values are available, Project holders shall used site specific data in order to calculate this parameter. The data used for this purpose shall be included in the monitoring plan of the project document. Project holder may directly measure the ratio of the total nitrogen content in the effluents entering and leaving a given treatment stage. Total nitrogen determination shall be performed according to the guidance provided in Annex 3.
Any comment:	For baseline and project emissions calculations this parameter may be estimated from Table provided in Annex 1. The most conservative value for the given technology must be used.

Data / Parameter Table 52

Data / Parameter:	EFN2O,D,n
Data unit:	kg N2O-N/ kg N
Description:	Direct N2O emission factor for treatment stage n
Source of data:	Project holders or 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, Table 10.21 (Updated)
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly
QA/QC procedures:	If no appropriate default values are available, for project emission calculations, Project holders shall used site specific data in order to calculate this parameter. The data used for this purpose shall be included in the monitoring plan of the project document.
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values may be used, if country specific or region specific data are not available

Data / Parameter Table 53

Data / Parameter:	EFN2O,Comp,D
Data unit:	kg N2O-N/ kg N
Description:	Direct N2O emission factor for composting
Source of data:	Project holders or 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023)
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly
QA/QC procedures:	If no appropriate default values are available, for project emission calculations, project holders shall used site specific data in order to calculate this parameter. The data used for this purpose shall be included in the monitoring plan of the project document.
Any comment:	2019 Refinement to the 2006 IPCC Guidelines default values may be used, if country specific or region-specific data are not available

Data / Parameter Table 54

Data / Parameter:	T
Data unit:	ºC
Description:	Monthly average ambient temperature at the livestock farms included in the project boundary.
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Daily aggregated for monthly average
QA/QC procedures:	---
Any comment:	Used to select the annual MCF_j from 2019 Refinement to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, Table 10.17 (Updated)

Data / Parameter Table 55

Data / Parameter:	T2,m
Data unit:	Kelvin
Description:	Monthly average ambient temperature at the manure storage tanks
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Daily aggregated for monthly average
QA/QC procedures:	---
Any comment:	

Data / Parameter Table 56

Data / parameter:	FCi,f
Data unit:	volume unit (liter)
Description:	Total quantity of consumed fuel type f in volume units in year y
Source of data:	Project holders
Measurement procedures (if any):	The receipts issued by the fuel supplier firm for the fuel type f are the primary source for the quantification of this parameter. Data will be acquired based on the measurement of the quantity of fuel type used.
Monitoring frequency:	Monthly

QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 57

Data / Parameter:	NCVf
Data unit:	TJ/t or TJ/m3
Description:	Net calorific value of fuel type f in TJ per volume or mass units
Source of data:	Source of data shall be determined in the preference order below Values provided by the fuel supplier in invoices Regional or national default values IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	In the case of utilizing regional and national default values appropriateness of these values shall be assessed annually In the case of utilizing IPCC 2006 default values, latest refinement to IPCC Guidelines shall be taken into consideration and equivalent values shall be used.

Data / Parameter Table 58

Data / Parameter:	EFCO2,f
Data unit:	tCO2e/TJ
Description:	CO2 emission factor of the fossil fuel type f used in transportation vehicles
Source of data:	Source of data shall be determined in the preference order below Values provided by the fuel supplier in invoices Regional or national default values IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	In the case of utilizing regional and national default values appropriateness of these values shall be assessed annually and most conservative value shall be used. In the case of utilizing IPCC 2006 default values, latest refinement to IPCC Guidelines shall be taken into consideration and equivalent values shall be used.

Data / Parameter Table 59

Data / parameter:	NEXLT,y
Data unit:	kg N/animal/year
Description:	Annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 6
Source of data:	Refer to Annex 6

Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 60

Data / parameter:	VSLT,y
Data unit:	Kg-VS-dry matter/animal/year
Description:	Volatile solid excretion per animal per day
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually, estimated or based on published information such as IPCC
QA/QC procedures:	---
Any comment:	If the default value is taken from the IPCC Guidelines, the most up-to-date version shall be used.

Data / Parameter Table 61

Data / parameter:	NLT,y
Data unit:	Number
Description:	Average livestock population used in both baseline and project case emissions estimation.
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly aggregated annually
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the number of livestock population. The consistency between the value and indirect information (records of sales, records of food purchases) shall be assessed

Data / Parameter Table 62

Data / parameter:	Nda
Data unit:	Number
Description:	Number of days animal is alive in the farm in the year y
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly aggregated annually
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the number of days animal is alive in the farm.

Data / Parameter Table 63

Data / parameter:	Np
Data unit:	Number
Description:	Number of animals produced annually of type LT for the year y
Source of data:	Project holders

Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the number of livestock population

Data / Parameter Table 64

Data / parameter:	NAA
Data unit:	Number
Description:	Daily stock of animals in the farm, discounting dead and discarded animals
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly aggregated annually
QA/QC procedures:	---
Any comment:	This parameter is only used if the project holder can monitor in a reliable and traceable way the daily stock of animals in the farm, discounting dead animals and animals discarded from the productive process from the daily stock. In the case that monthly data is not available, the average of available data may be utilized. Alternatively, any official records sourced from authorized entities may be utilized. Appropriateness of these alternative methods shall be validated by the CAB.

Data / Parameter Table 65

Data / parameter:	Wsite
Data unit:	kg
Description:	Weight of livestock
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly
QA/QC procedures:	---
Any comment:	This parameter is used in equation 17 for estimating VSLT,y using option 3, and in option 3 (appendix 6) for estimating NEXLT,y when using 2019 Refinement to IPCC 2006 default values. Sampling procedures can be used to estimate this variable, taking into account the following guidance: To ensure representativeness, each defined livestock population shall be classified into a minimum of three age categories; For each defined livestock population, a minimum of one monthly sample per age category shall be taken; When estimating baseline emissions and emissions released during baseline scenario from land application of the treated manure in the leakage section, the lower bound of the 95% confidence interval obtained from the sampling measurements shall be used; When estimating project emissions and emissions released during project activity from land application of the treated manure in the leakage section, the upper bound of the 95% confidence interval obtained from the sampling measurements shall be used. These bounds shall be applied for parameter estimation only and do not replace the 90% confidence interval requirement under Section 14.

	The PD shall describe the system of random sampling taking into account stratification of each livestock population into a minimum of three weight categories as described above

Data / Parameter Table 66

Data / parameter:	GELT
Data unit:	MJ/day
Description:	Daily average gross energy intake on dry matter basis
Source of data:	Calculated as per Equation 10.16. of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023), Volume 4, Chapter 10, or use default value of 18.45 MJ/kg of dry matter if field specific information is not available
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 67

Data / parameter:	DELT
Data unit:	Fraction
Description:	Digestible energy of the feed in percent
Source of data:	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019, as updated in July 2023) Table 10.2
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 68

Data / parameter:	$UE \times GE_{LT}$
Data unit:	Fraction
Description:	Urinary energy expressed as fraction of GE
Source of data:	Typically 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 69

Data / parameter:	ASH
Data unit:	Fraction
Description:	Ash content of manure calculated as a fraction of the dry matter feed intake
Source of data:	Use country-specific values where available
Measurement procedures (if any):	Archive electronically during project plus 5 years

Monitoring frequency:	Monthly
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 70

Data / parameter:	EDLT
Data unit:	MJ/kg
Description:	Energy density of the feed fed to livestock type LT
Source of data:	---
Measurement procedures (if any):	Archive electronically during project plus 5 years. The project holder will record the composition of the feed to enable the CAB to verify the energy density of the feed
Monitoring frequency:	---
QA/QC procedures:	The project holder will record the composition of the feed to enable the CAB to verify the energy density of the feed
Any comment:	IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg-dm, which is relatively constant across a wide variety of grain-based feeds

Data / Parameter Table 71

Data / parameter:	N
Data unit:	-
Description:	Total numbers of farms
Source of data:	Project holders
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter Table 72

Data / parameter:	Bo,EM,m
Data unit:	m3CH4/ton-VS
Description:	Average monthly CH4 production capacity of effluent manure entering the aerobic treatment stage
Source of data:	Project holders
Measurement procedures (if any):	Measured as per: ISO 11734:1995 ASTM D 5210-92.
Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	
Any comment:	

Data / Parameter Table 73

Data / parameter:	$B_{0,res,m}$
Data unit:	m3CH4/ton-VS
Description:	Average monthly CH4 production capacity of residues entering the composting step
Source of data:	Project holders
Measurement procedures (if any):	Measured as per: ISO 11734:1995 ASTM D 5210-92.

Monitoring frequency:	Weekly aggregated for monthly average
QA/QC procedures:	
Any comment:	

Data / Parameter Table 74

Data / parameter:	All
Data unit:	Days
Description:	Annual average interval between manure collection procedures at a given storage tank l
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Discontinuous daily for estimating annual average
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 75

Data / parameter:	MS%l
Data unit:	Fraction
Description:	Fraction of volatile solids (%) handled by storage tank l
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Monthly averaged for annual value
QA/QC procedures:	---
Any comment:	---

Data / Parameter Table 76

Data / Parameter:	MS%Bl,j
Data unit:	Fraction
Description:	Fraction of manure handled in system j in the baseline
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the fraction of manure handled in system j in the baseline.

Data / Parameter Table 77

Data / Parameter:	MS%,j
Data unit:	Fraction
Description:	Fraction of manure handled in system j in the project activity
Source of data:	Project holders
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the fraction of manure handled in system j in the project activity.

Data / Parameter Table 78

Data / Parameter:	FAer
Data unit:	Fraction
Description:	Fraction of volatile solids directed to aerobic treatment
Source of data:	-
Measurement procedures (if any):	Archive electronically during project plus 5 years
Monitoring frequency:	Annually
QA/QC procedures:	---
Any comment:	The PD shall describe the system on monitoring the fraction of volatile solids directed to aerobic treatment

Data / Parameter Table 79

Data / Parameter:	Wx
Data unit:	tonnes/year, wet basis
Description:	Total amount of organic waste type j prevented from disposal in the SWDS through co-digestion with animal manure in the anaerobic digester(s)/reactor(s) in the year x
Source of data:	Project holders
Measurement procedures (if any):	Measure on wet basis. This parameter shall be directly monitored via weighbridge records for every organic waste type j acceptance.
Monitoring frequency:	Continuously, aggregated at least annually for year x
QA/QC procedures:	Weighbridge will undergo maintenance/calibration subject to appropriate industry standards. This maintenance/calibration practice shall be clearly stated in the project document.
Any comment:	-

Document History

Document type. **Methodological document.**

Biomethanisation Plants: Animal Manure Management for Renewable Energy, Heat Generation, and CH_4 & N_2O Mitigation

Version	***Date***	***Description***
Internal consultation	March 27, 2024	Initial version Document submitted for internal review
Document for public consultation	May 24, 2024	Document submitted for public consultation
Version 1.0	July 4, 2024	Version issued after public consultation
Public Consultation Version 2.0	February 19, 2026	Public consultation draft. Structural and substantive update aligning baseline reassessment, additionality, leakage, uncertainty and MRV provisions with current BioCarbon program tools.