



METHODOLOGICAL DOCUMENT WASTE HANDLING AND DISPOSAL

BCR0021

Recovery, Destruction and Utilization of
Methane from Landfill Gas

BIOCARBON CERT®

Draft for public consultation | October 21, 2026

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BIOCARBON CERT. 2026. BCR0021. Recovery, Destruction and Utilization of Methane from Landfill Gas. Public consultation draft. 21 October 2026. 60 p.

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Acronyms and Abbreviations

ADC	Avoiding Double Counting
BAT	Baseline and Additionality Tool
BE	Baseline emissions
CAB	Conformity Assessment Body
CDM	Clean Development Mechanism
CH ₄	Methane
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
EF	Emission factor
ER	Emission reductions
GHG	Greenhouse gases
GJ	Gigajoule
GWP	Global warming potential
IPCC	Intergovernmental Panel on Climate Change
LE	Leakage emissions
LFG	Landfill gas
MRV	Monitoring, reporting and verification
MWh	Megawatt-hour
N ₂ O	Nitrous oxide
NCV	Net calorific value
PE	Project emissions
QA/QC	Quality assurance and quality control
SDG	Sustainable Development Goal
SDS	Sustainable Development Safeguards
SWDS	Solid waste disposal site
t	Metric tonne
tC	Metric tonne of carbon
tCO ₂	Metric tonne of carbon dioxide
tCO ₂ e	Metric tonne of carbon dioxide equivalent
TDL	Transmission and distribution losses
TJ	Terajoule
UNFCCC	United Nations Framework Convention on Climate Change
VCC	Verified Carbon Credit

1 Introduction

Global municipal solid waste generation continues to rise as a result of population growth, urbanization and consumption patterns. According to the World Bank (2026), in its report “What a Waste 3.0”, approximately 2.56 billion tonnes of municipal waste were generated in 2022. If current trends continue, this amount could reach 3.86 billion tonnes per year by 2050, an increase of almost 50%. The highest growth rates are projected for Sub-Saharan Africa and South Asia, where the expansion of waste management and final disposal systems presents significant infrastructure and emissions-mitigation challenges.

The anaerobic decomposition of biodegradable waste deposited at disposal sites generates gas composed mainly of methane (CH₄) and carbon dioxide (CO₂). These emissions may continue during site operation and after closure. The United Nations Environment Programme and the Climate and Clean Air Coalition (2021) estimate that the waste sector, including solid waste and wastewater, accounts for approximately 20% of global anthropogenic methane emissions. Recovering and destroying this gas provides an opportunity to reduce greenhouse gas (GHG) emissions.

These measures have potential applications in countries with varying levels of waste disposal infrastructure development, particularly in Latin America, Asia and Africa. Countries such as Brazil, Mexico, Chile, Peru, Indonesia, Pakistan, South Africa and Egypt present diverse circumstances in which landfill gas recovery and management activities can be assessed. Opportunities include facilities without methane destruction systems, expansions and upgrades of existing systems, reactivation of inactive facilities, and gas recovery at closed or post-closure sites.

Gas recovery enables the destruction of methane that would otherwise be released to the atmosphere in the absence of the project activity. Recovered gas may also be used to generate electricity, produce thermal energy, provide combined heat and power, or supply other eligible energy applications. Flaring may constitute a stand-alone mitigation activity without necessarily requiring energy recovery.

This methodology establishes the applicability conditions and procedures for quantifying GHG emission reductions arising from these activities. It covers new and existing systems, expansions, upgrades and reactivations, as well as combinations of technologies and gas uses. It provides a technical framework for developing projects of different scales and configurations, based on baseline determination, demonstration of additionality, monitoring and verification of the emission reductions actually achieved.

The methodology is technically based on approaches developed under the Clean Development Mechanism (CDM), particularly ACM0001, “Flaring or use of landfill gas”, and AMS-III.G, “Landfill methane recovery”, together with relevant procedures for energy recovery and emissions quantification. It applies globally and shall be implemented in accordance with the BCR Standard and the applicable BioCarbon Tools.

2 Sources

The technical development of this methodology is based primarily on the following sources:

United Nations Framework Convention on Climate Change (UNFCCC). ACM0001. Flaring or use of landfill gas. Version 19.0.

United Nations Framework Convention on Climate Change (UNFCCC). AMS-III.G. Landfill methane recovery. Version 10.0.

United Nations Framework Convention on Climate Change (UNFCCC). AMS-I.D. Grid connected renewable electricity generation. Version 18.0.

United Nations Framework Convention on Climate Change (UNFCCC). AMS-I.C. Thermal energy production with or without electricity. Version 22.0.

United Nations Framework Convention on Climate Change (UNFCCC). TOOL04. Emissions from solid waste disposal sites. Version 8.1.

CDM methodological tools addressing emissions from flaring, determination of the mass flow of GHGs in gaseous streams, electricity consumption and generation, fossil fuel combustion, and the efficiency of energy generation systems shall be used where their procedures are relevant to the activities and emission sources covered by this methodology.

United Nations Framework Convention on Climate Change (UNFCCC). A6.4-AMM-001. Flaring or use of landfill gas. Version 01.0.

IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste.

IPCC. 2019. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste.

ACM0001 is the main technical reference for landfill gas recovery, destruction and utilization. AMS-III.G and supplementary CDM methodologies and tools provide references for small-scale configurations, energy recovery, emissions quantification and monitoring procedures, as applicable.

A6.4-AMM-001 is considered a reference for assessing the technical correspondence of this methodology with the requirements of the mechanism established under Article 6.4 of the Paris Agreement.

The IPCC Guidelines provide the scientific basis for waste characterization, methane generation and the estimation of emissions from solid waste disposal sites.

The external sources identified in this section are references used in developing the methodology. Their provisions do not automatically become normative requirements unless this methodology expressly establishes their application.

The applicable BioCarbon documents and tools are identified in the section addressing the normative framework of this methodology.

3 Objectives

The objectives of this methodology are to:

- a) Establish eligibility conditions for landfill gas recovery, destruction and utilization, including new and existing systems.
- b) Determine baseline scenarios and procedures for quantifying GHG emission reductions from methane destruction and energy recovery.
- c) Establish procedures for quantifying project emissions, leakage and net emission reductions, including those resulting from expansions, upgrades and reactivations.
- d) Define the parameters and monitoring requirements needed to support quantification and verification of mitigation outcomes.

4 Version and validity

The status and publication date of this methodology are indicated on the cover. The approved version and its effective date shall be identified in the official publication.

The methodology shall remain valid until revised or withdrawn by BioCarbon Cert. Project Holders shall apply the appropriate version in accordance with the BCR Standard and applicable transition provisions.

5 Scope

This methodology applies globally to project activities that reduce greenhouse gas (GHG) emissions through the recovery, destruction and utilization of gas generated by the anaerobic decomposition of waste at solid waste disposal sites.

It covers the installation and operation of methane capture and destruction systems, as well as the utilization of recovered gas for electricity generation, thermal energy production, cogeneration and other energy uses expressly covered by the quantification procedures in this methodology.

It may be applied to operating, closed or post-closure landfills through new systems, expansions, upgrades, reactivations or the addition of energy recovery to existing facilities. In all cases, only emission reductions that are additional to the applicable baseline scenario may be credited.

Activities may combine different technologies and gas uses within a single project, provided emission reductions are quantified without double counting and the relevant applicability conditions are met.

Waste prevention, separation, recycling or alternative treatment activities intended to avoid final disposal fall outside the scope, as does any technology or gas use for which this methodology does not establish a complete quantification procedure.

This methodology quantifies GHG emission reductions only, not carbon dioxide removals.

6 Applicability conditions

This methodology applies when all the following conditions are met:

- a) The gas originates from the anaerobic decomposition of waste deposited at identifiable solid waste disposal sites, including operating sites, sites undergoing closure, closed sites and sites in the post-closure phase.
- b) The project activity involves installing, operating, expanding, upgrading or reactivating gas capture, destruction or utilization systems, including interventions in pre-existing systems.
- c) The recovered gas is destroyed in flares or other eligible devices, or utilized for electricity generation, thermal energy production, cogeneration, fuel substitution or supply to consumers, in accordance with the quantification procedures established in this methodology.
- d) Activities may include new disposal cells, extensions to gas collection networks, efficiency improvements, installation of destruction or energy recovery equipment, and gas recovery at sites undergoing closure or rehabilitation, provided they generate additional and verifiable emission reductions.
- e) Applicable legal, regulatory, environmental and contractual obligations, as well as pre-existing systems and practices, are considered when determining the baseline scenario and assessing additionality.
- f) For existing systems, expansions, upgrades and reactivations, the reductions attributable to the project can be distinguished from those that would have occurred without the intervention, considering the expected development of gas generation, capture and destruction.
- g) Where displacement of electricity, fuels or thermal energy is claimed, the displaced energy source is identified and the corresponding reductions are quantified without crediting again any methane destruction that would have occurred in the baseline.
- h) Gas flows, methane content, actual destruction, losses and energy outcomes can be determined through verifiable procedures and reconciled across different devices and uses.

- i) Where gas is supplied to third parties, measurement and traceability mechanisms are in place to identify quantities delivered, their use and the attribution of mitigation outcomes.
- j) The project activity complies with the applicable requirements of the BCR Standard and BioCarbon Tools, including those concerning the baseline, additionality, monitoring and avoidance of double counting.
- k) The project activity does not reduce the amount of organic waste that would have been sent for recycling or other alternative treatment in its absence. Nor shall it hinder waste separation, recycling, composting or diversion measures that are legally required or formally adopted for the site, or use carbon-credit revenues to deliberately prolong waste disposal.
- l) During the crediting period, waste disposal site management practices are not deliberately altered to increase methane generation relative to the conditions existing before implementation of the project activity.

The installation of equipment, compliance with regulatory obligations or changes in the destination of recovered gas do not, in themselves, demonstrate additional emission reductions.

7 Methodology type and modular architecture

This is a project-scale baseline and monitoring methodology for quantifying GHG emission reductions arising from landfill gas recovery, destruction and utilization.

Its modular architecture consists of this methodology and the applicable BioCarbon Tools, which jointly establish eligibility, baseline, additionality, quantification, monitoring and other Program requirements.

The methodology shall be applied together with the following BioCarbon documents and tools:

- a) BCR Standard, Version 4.1, or the applicable subsequent version.
- b) Baseline and Additionality Tool, Version 2.1.
- c) Monitoring, Reporting and Verification Tool, Version 2.0.
- d) Leakage Management Tool, Version 1.0.
- e) Conservative Approach and Uncertainty Management Tool, Version 1.0.
- f) Avoiding Double Counting Tool, Version 3.1.
- g) Sustainable Development Safeguards Tool, Version 2.1.1.
- h) SDG Contribution Tool, Version 2.0.
- i) Any other documents and tools required by the BCR Standard, where applicable.

The tools shall be applied in their effective versions in accordance with the transition provisions of the BCR Standard. The specific requirements of this methodology supplement the applicable tools without replacing or weakening their provisions.

8 Terms and definitions

The definitions in the BCR Standard and the corresponding BioCarbon Tools apply. For the purposes of this methodology, the following definitions are established:

Additional methane destruction

The amount of methane actually destroyed by the project activity in excess of the destruction corresponding to the baseline scenario, determined in accordance with the quantification procedures of this methodology.

Baseline methane destruction

The amount of methane that would have been destroyed in the absence of the project activity, considering operating conditions, pre-existing systems and applicable requirements.

Energy utilization of gas

Use of recovered gas to produce electricity, thermal energy or combined heat and power, or to supply fuel for eligible energy applications.

Expansion of the gas collection system

Addition of gas recovery infrastructure or capacity to an existing system, including new collection networks, wells or connected disposal cells.

Flare

A device used to destroy methane contained in a gaseous stream through controlled combustion.

Gas collection system

A set of wells, pipes, headers, extraction equipment and other components used to recover gas generated at a solid waste disposal site.

Landfill gas (LFG)

A mixture of gases generated by the anaerobic decomposition of organic waste at solid waste disposal sites, consisting mainly of methane (CH₄) and carbon dioxide (CO₂).

Methane destruction

Conversion of the methane contained in recovered gas through combustion or another destruction process expressly covered by this methodology.

Methane destruction efficiency

The proportion of methane entering a destruction device that is actually destroyed during its operation.

Pre-existing gas management system

Gas collection, destruction or utilization infrastructure installed before implementation of the measures proposed by the project activity.

System reactivation

Resumption of operation of a gas collection, destruction or utilization system that was inactive before the project intervention.

System upgrade

A technological or operational modification to an existing system intended to improve its gas capture, destruction or utilization performance.

9 Eligible activities

Eligible project activities comprise measures to recover, destroy or utilize landfill gas and generate additional GHG emission reductions relative to the applicable baseline scenario.

Activities may include:

- a) Installation and operation of new methane capture and destruction systems using flares or other eligible devices.
- b) Gas recovery and utilization for electricity generation, self-consumption, third-party supply or delivery to the electricity grid.
- c) Gas utilization for thermal energy production, substitution of fossil fuels or cogeneration of electricity and heat.
- d) Conditioning, treatment and supply of recovered gas for energy applications expressly covered by the quantification procedures in this methodology.
- e) Expansion of existing collection systems, including the addition of new wells, extraction networks and disposal cells.
- f) Upgrading existing systems to improve gas capture, destruction or utilization efficiency.
- g) Reactivation of inactive gas capture, destruction or utilization systems where additional reductions relative to the baseline scenario can be demonstrated.

h) Installation of energy recovery systems at facilities that previously captured and destroyed methane.

i) Gas recovery, destruction or utilization at disposal sites undergoing closure, closed sites or post-closure sites.

Activities may be implemented individually or combined within a single project. Where different devices or energy applications are used, gas flows and corresponding reductions shall be determined without double counting.

Infrastructure construction, installation of equipment or an increase in operating capacity does not, by itself, generate creditable emission reductions. Only additional and verifiable outcomes may be quantified in accordance with this methodology and the applicable BioCarbon Tools.

10 Landfill gas and eligible technologies

Gas eligible under this methodology shall originate from the anaerobic decomposition of waste deposited at identifiable solid waste disposal sites. Its origin, composition and quantity shall be determinable through verifiable procedures.

Eligible systems and technologies include:

a) Active or passive gas collection systems, including wells, pipes, headers, extraction and conveyance equipment. Capture alone does not generate creditable reductions without demonstrating eligible destruction or utilization of the recovered methane.

b) Open or enclosed flares and other combustion devices provided the amount of methane actually destroyed can be determined in accordance with the applicable quantification and monitoring procedures.

c) Engines, turbines and other electricity generation equipment fueled by recovered gas, including systems for self-consumption, third-party supply and grid injection.

d) Boilers, air heaters, glass-melting furnaces and brick kilns, in accordance with the quantification procedures established in this methodology. Heat exchangers and other auxiliary components may form part of these systems without constituting a separate crediting pathway.

e) Combined heat and power systems producing electricity and useful thermal energy from recovered gas.

f) Gas conditioning, purification, compression and supply systems for eligible energy applications, including biomethane production facilities, where complete procedures are available to quantify the corresponding emissions, losses and energy outcomes.

Systems may operate independently or as integrated installations. Where gas is distributed among several devices, the quantities assigned to each use, the losses and the methane actually destroyed shall be identified and reconciled.

The following are not eligible for quantification under this methodology:

- a) Gas originating from anaerobic digesters, wastewater treatment plants or processes other than the decomposition of waste at solid waste disposal sites.
- b) Gas venting, extraction or conveyance without eligible and verifiable methane destruction or utilization.
- c) Amounts of methane that would have been destroyed under the baseline scenario where they are claimed again as additional reductions because of a change in technology or gas destination.
- d) Technologies or applications for which this methodology does not establish complete quantification and monitoring procedures.

Eligibility of a technology does not mean that all the gas recovered or energy generated produces creditable reductions. Such reductions shall be determined in accordance with the baseline scenario and the applicable quantification procedures.

11 Baseline scenario

11.1 General requirements

The baseline scenario shall be determined in accordance with the BioCarbon Baseline and Additionality Tool and the specific requirements of this methodology. It shall represent the most plausible and conservative situation that would occur in the absence of the project activity.

Baseline determination shall consider site operating conditions, existing gas collection, destruction and utilization systems, applicable legal and contractual obligations, and the expected development of biogas generation and management.

Where the project combines methane destruction with energy recovery, baseline emissions corresponding to each outcome shall be determined separately, avoiding overlap.

11.2 Identification of alternative scenarios

In addition to the alternatives considered under the Baseline and Additionality Tool, the following shall be assessed where technically feasible and legally permitted:

- a) Release of gas without capture or destruction.
- b) Continued operation of existing gas collection, flaring or energy recovery systems.

- c) Installation or expansion of gas capture and destruction systems without carbon-credit revenue.
- d) Gas utilization for electricity generation, thermal energy production or other energy uses without project registration.
- e) Upgrading, replacement or reactivation of equipment that would reasonably occur in the absence of the project activity.
- f) Compliance with applicable site obligations for gas collection, treatment or destruction.

For new solid waste disposal sites, the identification of alternative scenarios shall also consider waste treatment and management options that are technically feasible, legally permissible and economically accessible, in accordance with the BioCarbon Baseline and Additionality Tool.

The alternatives shall be assessed considering the relevant technical, economic, regulatory and operating conditions.

11.3 Determination of baseline methane destruction

The amount of methane that would have been destroyed in the absence of the project shall be determined considering pre-existing capture and destruction, applicable obligations and the expected performance of gas management systems.

For facilities without capture or destruction systems, baseline methane destruction may be set to zero only where it is demonstrated that no gas recovery or destruction would have occurred in the absence of the project.

Where gas collection, flaring or energy recovery systems exist, the baseline shall include the methane destruction that would reasonably have continued without the intervention.

Baseline methane destruction shall be quantified using the procedures established in the quantification section of this methodology.

11.4 Existing systems, expansions and upgrades

For expansions and upgrades, the baseline shall reflect the operations and performance that would have continued without the intervention, including expected changes in gas generation, capture capacity and equipment service life.

Historical records may be used where they are representative and verifiable. Where operating conditions have changed materially, technically justified and conservative adjustments shall be applied.

An increase in gas recovered or destroyed relative to a historical period does not, in itself, constitute an additional emission reduction attributable to the project.

11.5 Reactivation of inactive systems

For inactive systems, it shall be determined whether operations would have resumed in the absence of the project, considering the reasons for shutdown, applicable obligations, operating records and planned investments or maintenance activities.

Historical inactivity shall not automatically be used to establish a baseline without methane capture or destruction.

11.6 Baseline energy recovery

Where emission reductions from energy recovery are quantified, the electricity, fuel or thermal energy that would have been supplied or consumed in the absence of the project shall be identified.

For systems that already destroy methane by flaring, the addition of electricity generation or thermal energy recovery shall not allow the methane destruction that would have occurred in the baseline to be credited again.

Emission reductions from energy displacement shall be determined using eligible energy quantities and applicable emission factors, in accordance with the quantification procedures of this methodology.

11.7 Data and evidence

The baseline shall be supported by representative and verifiable information, including operating records, gas measurements, waste characteristics, equipment specifications, environmental permits, contractual obligations and relevant energy data.

Where sources of information conflict or material uncertainty exists, the procedures and conservative adjustments established in the corresponding BioCarbon Tools shall be applied.

11.8 Baseline reassessment

The baseline shall be reassessed in accordance with the time frames and conditions established in the BCR Standard and the Baseline and Additionality Tool.

It shall also be reviewed when material changes occur in regulatory obligations, landfill operating conditions, gas collection and destruction systems, available technologies or displaced energy sources that may affect its validity or conservativeness.

12 Additionality

The additionality of project activities shall be demonstrated in accordance with the applicable BioCarbon Baseline and Additionality Tool. The requirements of this section supplement that tool and do not replace its procedures.

The assessment shall consider legal, regulatory and contractual obligations relating to gas capture, destruction and utilization, as well as existing practices and the technical and economic circumstances of the activity.

For existing systems, expansions, upgrades or reactivations, additionality shall be demonstrated in relation to the measures producing incremental emission reductions, rather than to the pre-existing infrastructure as a whole.

Where energy recovery is added to an existing gas capture and destruction system, the assessment shall consider the revenues, savings and benefits associated with the energy produced, in accordance with the applicable procedures of the Baseline and Additionality Tool.

The installation of equipment, increased capacity, gas recovery at a closed site or the existence of a baseline without methane destruction do not, in themselves, demonstrate additionality.

Requirements concerning prior consideration, project start date and retroactivity shall apply in accordance with the BCR Standard. Additionality shall be reassessed when required by the Program provisions.

13 Project boundaries

13.1 General requirements

The project boundary shall encompass the facilities, processes and GHG emission sources necessary to quantify baseline emissions, project emissions and leakage attributable to the activity.

The project boundary shall be consistent with eligible activities, the baseline scenario and the quantification and monitoring procedures established in this methodology.

13.2 Physical and geographical boundaries

The physical and geographical boundaries shall include, as applicable, the solid waste disposal site, disposal cells and gas generation areas, collection and conveyance systems, treatment and destruction equipment, and energy recovery facilities.

Where gas is supplied to third parties, the delivery points and end-use facilities or applications needed to demonstrate its utilization and quantify the corresponding reductions shall be identified.

For projects covering several sites or facilities, each shall be identified, and its gas flows and mitigation outcomes shall be determined in a verifiable manner.

13.3 GHG accounting boundary

The accounting boundary shall include the emission sources relevant to each activity, considering:

- a) Methane emissions that would occur under the baseline scenario, including pre-existing methane destruction or destruction required by applicable obligations.
- b) Methane recovered and actually destroyed by flares, engines, turbines or other eligible devices.
- c) Residual methane emissions and GHG emissions associated with the operation of gas collection, treatment, destruction and utilization systems.
- d) Electricity, fuel and other energy sources consumed by the project activity.
- e) Baseline emissions associated with displaced electricity or thermal energy, where applicable.
- f) Leakage emissions attributable to the project activity that occur outside the defined boundary.

GHG emission sources included within the project boundary are identified in Table 1. The emission reduction mechanisms associated with eligible activities are presented in Table 2. Their inclusion in accounting shall depend on the characteristics of the activity and the applicable quantification procedures.

Table 1. GHG emission sources included within the project boundary

Scenario	Emission source	GHG	Inclusion	Justification
Baseline	Methane emissions from anaerobic decomposition of waste at the disposal site	CH ₄	Yes	Main source of emissions avoided through methane recovery and destruction, accounting for oxidation and baseline destruction (Section 14.2.1).
Baseline	Displaced electricity generation	CO ₂	Conditional	Applicable where the project displaces electricity from an eligible baseline source (Section 14.2.2).
Baseline	Displaced fossil-fuel-based thermal energy generation	CO ₂	Conditional	Applicable where displacement of baseline heat generation is demonstrated (Section 14.2.3).
Baseline	Displaced natural gas consumption	CO ₂	Conditional	Applicable where recovered gas displaces natural gas supplied to consumers (Section 14.2.4).
Project	Methane not destroyed during flaring	CH ₄	Yes, integrated accounting	Taken into account when determining the amount of methane actually destroyed. Not deducted again as a

Scenario	Emission source	GHG	Inclusion	Justification
				separate emission (Section 14.2.1.2).
Project	Gas losses during collection, treatment, conveyance and storage	CH ₄	Conditional, integrated accounting	Methane losses shall be reflected in the balance of recovered gas actually supplied to eligible devices. Lost methane shall not be counted as destroyed or utilized. Additional project-attributable emissions not reflected in that balance shall be assessed and accounted for where applicable, avoiding double counting.
Project	Electricity consumption by gas recovery, treatment and utilization systems	CO ₂	Conditional	Emissions attributable to project electricity consumption, in accordance with Section 14.3.1.
Project	Fossil fuel combustion in auxiliary equipment and operations	CO ₂	Conditional	Emissions from fossil fuel consumption attributable to the project (Section 14.3.2).
Project	Transportation of compressed or liquefied landfill gas by truck	CO ₂	Conditional	Emissions from fossil fuel combustion during transport (Section 14.3.3).
Project	Methane losses during truck transport	CH ₄	Conditional	Difference between methane loaded and methane delivered to consumers (Section 14.3.3).
Project	Physical methane leaks from dedicated pipelines	CH ₄	Conditional	Emissions estimated using the applicable loss factor for gas supply by pipeline (Section 14.3.4).
Leakage	Additional emissions outside the project boundary	As applicable	Conditional	Project-attributable increases in emissions not accounted for in the preceding components (Section 14.4).

Table 2. Sources of GHG emission reductions

Activity	Source of emission reductions	GHG	Quantification condition
Collection and flaring	Additional methane destruction	CH ₄	Methane that would have been emitted in the absence of the project.

Activity	Source of emission reductions	GHG	Quantification condition
Collection and electricity generation	Additional methane destruction	CH ₄	Deduct destruction that would have occurred under the baseline.
Electricity generation	Displacement of baseline electricity	CO ₂	Eligible net electricity and applicable emission factor.
Thermal energy recovery	Substitution of fuels or thermal energy	CO ₂	Useful energy actually displaced.
Cogeneration	Additional methane destruction and energy displacement	CH ₄ , CO ₂	Separate quantification of electricity and thermal energy benefits.
Collection system expansion	Incremental methane recovery and destruction	CH ₄	Increase relative to baseline destruction.
System upgrade	Increase in methane destruction or energy recovery	CH ₄ , CO ₂	Additional reductions relative to counterfactual performance.
Reactivation	Additional destruction or utilization	CH ₄ , CO ₂	Demonstrate that reductions would not have occurred without the project.
Gas or biomethane supply	Substitution of conventional fuels	CO ₂	Eligible energy use, demonstrated displacement and accounting for losses.

Technical note: Pre-existing or mandatory methane destruction is not presented as an emission source in Table 1. It shall be considered in baseline determination and the corresponding equations. Similarly, residual methane emissions shall be accounted for only once, avoiding duplication between destruction efficiency and project emissions.

Emission sources shared by different devices or activities shall be identified and accounted for without duplication.

An emission source may be excluded only where its exclusion is conservative or its immateriality is demonstrated in accordance with applicable BioCarbon requirements.

13.4 Temporal boundary

The temporal boundary shall be consistent with the project start date, crediting period and monitoring periods established in the BCR Standard.

It shall include the historical period used to determine the baseline and the periods during which emission reductions are quantified and reported.

Baseline emissions, project emissions and leakage shall be assigned to non-overlapping monitoring periods.

Expansions, upgrades, reactivations and other changes that may affect the project boundary shall be documented and addressed in accordance with the applicable BioCarbon procedures.

14 Quantification of GHG emission reductions

14.1 General quantification approach

GHG emission reductions shall be quantified ex post on the basis of baseline emissions, project emissions and applicable adjustments determined under this methodology.

The quantification procedures for landfill gas recovery, destruction and utilization are based on ACM0001, Version 19.0, and the CDM methodological tools referenced therein. The relevant equations, parameters and monitoring requirements are retained unless specific adjustments are necessary to comply with applicable BioCarbon requirements.

Leakage emissions shall be assessed under the BioCarbon Leakage Management Tool. Uncertainty and conservative adjustments shall be addressed under the BioCarbon Conservative Approach and Uncertainty Management Tool. These requirements shall be applied without duplicating emissions already accounted for by the CDM quantification procedures.

Calculations shall be performed separately for each calendar year within the monitoring period. All GHG emissions shall be expressed in tonnes of CO₂ equivalent, using the global warming potential values required by the applicable BCR Standard.

14.2 Baseline emissions

Baseline emissions represent the GHG emissions that would have occurred in the absence of the project activity. They comprise methane emissions from the solid waste disposal site (SWDS) and, where applicable, emissions associated with displaced electricity generation, heat generation and natural gas consumption resulting from the utilization of recovered gas.

Each baseline emission component shall be quantified separately in accordance with the applicable procedures of ACM0001. Where a component does not apply to the project activity, its value shall be zero.

Baseline emissions in year y shall be calculated as follows:

$$BE_y = BE_{CH_4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \text{Equation 1}$$

Where:

BE_y	Total baseline emissions in year y ; tCO ₂ e/yr.
$BE_{CH_4,y}$	Baseline emissions of methane from the SWDS in year (y); tCO ₂ e/yr.
$BE_{EC,y}$	Baseline emissions associated with electricity generation in year (y); tCO ₂ /yr.
$BE_{HG,y}$	Baseline emissions associated with heat generation in year (y); tCO ₂ /yr.
$BE_{NG,y}$	Baseline emissions associated with natural gas use in year (y); tCO ₂ /yr.

The methane component shall be determined using the procedures described below. The electricity, heat and natural gas components shall be calculated using the corresponding equations and technical requirements established in ACM0001 and the applicable CDM methodological tools.

14.2.1 Baseline methane emissions

Baseline methane emissions shall be determined from the amount of methane recovered and destroyed or utilized by the project activity, considering the methane that would have been captured and destroyed under the baseline scenario.

The calculation shall account for methane oxidation in the top layer of the solid waste disposal site. This adjustment prevents crediting methane that would have been naturally oxidized before release into the atmosphere.

Methane destruction that would have occurred without the project, including destruction attributable to existing systems and applicable regulatory requirements, shall be deducted in accordance with the baseline determination procedures of ACM0001.

Baseline methane emissions in year y shall be calculated as follows:

$$BE_{CH_4,y} = [(1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y}] \times GWP_{CH_4} \quad \text{Equation 2}$$

Where:

$BE_{CH_4,y}$	Baseline methane emissions in year (y); tCO ₂ e/yr.
OX_{top_layer}	Fraction of methane in landfill gas that would be oxidized in the upper layer of the SWDS in the baseline; dimensionless.
$F_{CH_4,PJ,y}$	Amount of methane in landfill gas flared and/or utilized by the project activity in year (y); t CH ₄ /yr.
$F_{CH_4,BL,y}$	Amount of methane in landfill gas that would have been flared in the baseline in year (y); t CH ₄ /yr.
GWP_{CH_4}	Global warming potential of methane, as required by the applicable BCR Standard; tCO ₂ e/t CH ₄ .

The methane oxidation factor shall be determined in accordance with ACM0001.

The Project Holder shall document the type, extent and characteristics of the cover at the solid waste disposal site, including its condition and factors relevant to methane oxidation. The oxidation factor of 0.1 established in ACM0001, Version 19.0, shall be applied. Where verifiable technical evidence indicates that this value could lead to overestimation of emission reductions, a duly justified conservative adjustment shall be applied in accordance with the BioCarbon Baseline and Additionality Tool.

The amount of methane destroyed under the baseline scenario, $F_{CH_4,BL,y}$, shall be calculated using the procedures applicable to existing gas recovery systems and regulatory obligations. These procedures are developed in the following subsection on baseline methane destruction.

14.2.1.1 Methane recovered and utilized by the project activity

The amount of methane recovered and flared or utilized by the project activity shall be determined ex post from monitored landfill gas flows, their methane concentrations and the operating conditions of the corresponding equipment.

Where gas is allocated to several uses, methane quantities for each destination shall be determined separately. The calculation shall distinguish methane destroyed in flares, methane used for electricity generation, methane used for heat generation and methane supplied to consumers through eligible natural gas distribution arrangements.

The total amount of methane flared or utilized by the project in year y shall be calculated as follows:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y} + F_{CH_4,HG,y} + F_{CH_4,NG,y} \quad \text{Equation 3}$$

Where:

$F_{CH_4,PJ,y}$	Amount of methane in landfill gas flared and/or utilized by the project activity in year (y); t CH ₄ /yr.
$F_{CH_4,flared,y}$	Amount of methane destroyed by flaring in year (y); t CH ₄ /yr.
$F_{CH_4,EL,y}$	Amount of methane used for electricity generation in year (y); t CH ₄ /yr.
$F_{CH_4,HG,y}$	Amount of methane used for heat generation in year (y); t CH ₄ /yr.
$F_{CH_4,NG,y}$	Amount of methane supplied to consumers through a natural gas distribution network, dedicated pipeline or trucks in year (y); t CH ₄ /yr.

Methane mass flows shall be determined using the CDM methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.

For electricity and heat generation equipment, the amount of methane utilized shall be determined considering the operating hours of the corresponding equipment, in accordance with ACM0001.

Where several devices share a flow meter, the relevant requirements concerning equipment operation, allocation of flows and destruction efficiency shall be applied. The same amount of methane shall not be accounted for more than once.

14.2.1.2 Methane destroyed by flaring

Methane destruction by flaring shall be quantified from the amount of methane supplied to the flare and the emissions resulting from incomplete combustion.

The calculation shall reflect actual flare performance rather than assuming that all methane entering the flare is destroyed. Project emissions from flaring shall be determined using the applicable CDM methodological tool.

The amount of methane destroyed by flaring in year y shall be calculated as follows:

$$F_{CH_4,flared,y} = F_{CH_4,sent_flare,y} - \frac{PE_{flare,y}}{GWP_{CH_4}} \quad \text{Equation 4}$$

Where:

$F_{CH_4,flared,y}$	Amount of methane destroyed by flaring in year (y); t CH ₄ /yr.
$F_{CH_4,sent_flare,y}$	Amount of methane supplied to the flare in year (y); t CH ₄ /yr.
$PE_{flare,y}$	Project emissions from flaring in year (y); tCO ₂ e/yr.
GWP_{CH_4}	Global warming potential of methane, as required by the applicable BCR Standard; tCO ₂ e/t CH ₄ .

Emissions from methane not destroyed by flaring shall be determined from the mass of methane supplied and the destruction efficiency corresponding to each minute of operation.

For each flare, annual emissions shall be calculated using Equation 15 of CDM TOOLo6, Version 04.0:

$$PE_{flare,y} = GWP_{CH_4} \sum_{m=1}^{525600} [F_{CH_4,RG,m} (1 - \eta_{flare,m})] \times 10^{-3} \quad \text{Equation 5}$$

Where:

$PE_{flare,y}$	Emissions of methane not destroyed by the flare during year y; tCO ₂ e/yr.
GWP_{CH_4}	Global warming potential of methane required by the BCR Standard; tCO ₂ e/t CH ₄ .
$F_{CH_4,RG,m}$	Mass of methane supplied to the flare during minute m; kg CH ₄ .
$\eta_{flare,m}$	Methane destruction efficiency of the flare during minute m; dimensionless.
m	Minute of the year.
10^{-3}	Conversion factor from kilograms to tonnes.

The mass of methane supplied to the flare shall be determined in accordance with the procedure in Section 15.4.1, using the quantity corresponding to each minute of measurement.

The applicable destruction efficiency shall be determined in accordance with Section 15.4.2. For minutes during which valid flare operation cannot be demonstrated, efficiency shall be zero.

Where several flares are present, emissions shall be calculated individually and aggregated for the corresponding year.

The result of Equation 5 shall be used in Equation 4 to determine the methane actually destroyed. These emissions shall not be deducted again under Section 14.3 or Section 14.4.

14.2.1.3 *Ex ante estimation of recovered and utilized methane*

For ex ante estimation of emission reductions, the amount of methane expected to be recovered and flared or utilized by the project activity shall be estimated from the methane generation potential of the solid waste disposal site and the expected efficiency of the gas collection system.

This estimate shall be used for project design and ex ante calculations. Actual emission reductions shall be determined ex post using monitored methane flows and the applicable destruction or utilization procedures.

The ex-ante amount of methane recovered and utilized in year y shall be calculated as follows:

$$F_{CH_4,PJ,y} = \frac{\eta_{PJ} \times BE_{CH_4,SWDS,y}}{GWP_{CH_4}} \quad \text{Equation 6}$$

Where:

$F_{CH_4,PJ,y}$	Amount of landfill gas methane expected to be flared or utilized by the project in year y; t CH ₄ /yr.
η_{PJ}	Efficiency of the landfill gas collection system to be installed; dimensionless.
$BE_{CH_4,SWDS,y}$	Baseline methane emissions generated at the solid waste disposal site in year y; tCO ₂ e/yr.
GWP_{CH_4}	Global warming potential of methane; tCO ₂ e/t CH ₄ .

Baseline methane generation shall be estimated using the CDM methodological tool “Emissions from solid waste disposal sites”.

When applying TOOLo4 for this estimate, parameters f_y and OX_{top_layer} shall be set to zero because baseline methane destruction and oxidation in the site cover are accounted for

separately by the procedures in this methodology. The calculation shall include waste deposited since the first year of site operation.

14.2.1.4 Determination of baseline methane destruction

The amount of methane that would have been captured and destroyed in the absence of the project activity shall be determined considering the conditions existing at the project start date.

The determination shall consider regulatory and contractual obligations, safety and odor-control requirements, and existing landfill gas collection and destruction systems.

Four cases shall be distinguished according to whether there is an obligation to destroy methane and whether a pre-existing gas collection and destruction system is in place.

Case	Requirement to destroy methane	Existing LFG capture and destruction system
1	No	No
2	Yes	No
3	No	Yes
4	Yes	Yes

The applicable case shall be identified and justified in the Project Document, using the relevant regulatory, contractual, technical and operational evidence.

Case 1. No obligation to destroy methane and no existing LFG capture system

Where no obligation to capture and destroy methane exists and no landfill gas capture system was operating before the project activity, baseline methane destruction shall be zero.

$$F_{CH_4, BL, y} = 0 \quad \text{Equation 7}$$

This case applies only where both conditions have been demonstrated. The absence of a regulatory obligation does not, by itself, establish that baseline methane destruction is zero if an existing system is present.

Case 2. Obligation to destroy methane and no existing LFG capture system

Where methane destruction is required but no gas collection and destruction system exists at the project start date, baseline methane destruction shall correspond to the amount whose destruction is mandatory.

$$F_{CH_4,BL,y} = F_{CH_4,BL,R,y} \quad \text{Equation 8}$$

Where:

$F_{CH_4,BL,y}$	Amount of methane that would have been flared under the baseline in year y; t CH ₄ /yr.
$F_{CH_4,BL,R,y}$	Amount of methane whose flaring was mandatory under the baseline in year y; t CH ₄ /yr.

The required quantity shall be determined according to the nature of the applicable obligation.

Where the obligation specifies an absolute amount of methane that must be destroyed, that amount shall be used.

Where the obligation specifies a percentage of captured gas that must be destroyed, baseline methane destruction shall be determined as follows:

$$F_{CH_4,BL,R,y} = \rho_{reg,y} \times F_{CH_4,PJ,capt,y} \quad \text{Equation 9}$$

Where:

$\rho_{reg,y}$	Fraction of landfill gas required to be flared in year y; dimensionless.
$F_{CH_4,PJ,capt,y}$	Amount of methane captured by the project activity in year y; t CH ₄ /yr.

The amount of methane captured by the project shall be determined using one of the following options established in ACM0001:

- Measurement of the methane mass flow immediately downstream of the collection system and before the gas is distributed to different uses, applying the CDM tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.
- Sum of the methane flows supplied to flaring, electricity generation or heat generation equipment, without applying the adjustment for equipment operating hours used to calculate creditable methane utilization.

Where the obligation requires the installation of a gas collection system but does not require flaring or specify an amount of methane to be destroyed, baseline methane destruction attributable to that obligation shall be zero.

$$F_{CH_4,BL,R,y} = 0 \quad \text{Equation 10}$$

Where the obligation requires both collection and flaring but does not specify the quantity or percentage of methane to be destroyed, the default baseline destruction rate established in ACM0001 shall apply.

$$F_{CH_4,BL,R,y} = 0.2 \times F_{CH_4,PJ,capt,y} \quad \text{Equation 11}$$

The 0.2 factor is the default procedure established by ACM0001 for this specific situation and shall not be interpreted as a general baseline destruction factor applicable to all projects.

Case 3. No obligation to destroy methane and an existing gas collection system

Where a landfill gas collection system exists but methane destruction is not mandatory, the amount that would have been destroyed in the baseline shall be determined from the existing system.

In this situation, baseline methane destruction shall be determined as follows:

$$F_{CH_4,BL,y} = F_{CH_4,BL,sys,y} \quad \text{Equation 12}$$

$F_{CH_4,BL,sys,y}$ Amount of methane that would be flared in the baseline in year y by the existing landfill gas capture system; t CH₄/yr.

The applicable calculation shall depend on whether methane captured by the existing system can be monitored separately and whether historical operating records are available.

Existing collection system with independent monitoring

Where methane recovered by the existing system can be monitored separately from methane recovered through the project intervention, and the efficiency of the existing system is not affected by the project, baseline methane destruction shall be determined from the methane flow associated with the existing system.

$$F_{CH_4,BL,sys,y} = F_{CH_4,sent_flare,y} \quad \text{Equation 13}$$

Where:

$F_{CH_4,sent_flare,y}$ Amount of methane supplied to the flare by the existing collection system during year y; t CH₄/yr.

The methane flow shall be measured in the pipe collecting gas from the existing system, applying the relevant CDM tool for gaseous streams.

Existing collection system with historical data

Where independent monitoring is unavailable but historical data from the year preceding project implementation exist, baseline methane destruction shall be determined using the historical recovery and destruction performance.

$$F_{CH_4,BL,sys,y} = F_{CH_4,hist,y} \quad \text{Equation 14}$$

The historical amount shall be adjusted to reflect the methane generation conditions in the monitoring year, maintaining the historical proportion of methane recovered and destroyed.

$$F_{CH_4,hist,y} = \frac{F_{CH_4,BL,x-1}}{F_{CH_4,x-1}} \times F_{CH_4,PJ,y} \quad \text{Equation 15}$$

Where:

$F_{CH_4,hist,y}$ Historical amount of methane captured and destroyed, adjusted for year y; t CH₄/yr.
 $F_{CH_4,BL,x-1}$ Amount of methane captured and destroyed during the year preceding project implementation; t CH₄/yr.
 $F_{CH_4,x-1}$ Amount of methane generated at the disposal site during the year preceding project implementation; t CH₄/yr.
 $F_{CH_4,PJ,y}$ Amount of landfill gas methane captured by the project activity during year y; t CH₄/yr.

Methane generated during the year preceding project implementation shall be estimated using the CDM methodological tool “Emissions from solid waste disposal sites”.

Existing collection system without monitored or historical data

Where no monitored or historical data are available for methane captured in the year before implementation, ACM0001 establishes the following default procedure:

$$F_{CH_4,BL,sys,y} = 0.2 \times F_{CH_4,PJ,y}$$

Equation 16

The 20% factor is the default value established in ACM0001 for this specific situation. Its use remains subject to the applicability conditions of the methodology, including the requirements concerning historical data for certain existing active capture systems.

Case 4. Obligation to destroy methane and an existing LFG capture system

Where methane destruction is mandatory and an existing landfill gas capture system is present, baseline methane destruction shall account for both the applicable obligation and the destruction associated with the existing system.

To avoid overestimating emission reductions, the higher of these two values shall be used in the baseline.

$$F_{CH_4,BL,y} = \max \{ F_{CH_4,BL,R,y}; F_{CH_4,BL,sys,y} \}$$

Equation 17

Where:

$F_{CH_4,BL,R,y}$	Amount of methane that would be flared in the baseline due to applicable requirements in year y; t CH ₄ /yr.
$F_{CH_4,BL,sys,y}$	Amount of methane that would be flared in the baseline by the existing capture system in year y; t CH ₄ /yr.

The regulatory or contractual component shall be determined using the procedures for Case 2, while the existing-system component shall be determined using the procedures for Case 3.

The higher value shall be applied in the calculation of baseline methane emissions.

14.2.2 Baseline emissions associated with electricity generation

Baseline emissions associated with electricity generation shall be quantified where electricity generated from recovered landfill gas displaces electricity that would otherwise have been supplied by the grid or generated by fossil-fuel-fired captive power plants.

Baseline electricity supply shall be consistent with the most plausible baseline scenario identified for the project activity. The Project Holder shall identify and document the displaced electricity sources, their operating conditions and the corresponding electricity generation emission factors.

Baseline emissions shall be calculated using the CDM methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (TOOL05), in accordance with Section 5.4.2 of ACM0001.

For application of TOOLo5, electricity sources k shall be the sources identified in the baseline scenario. Baseline electricity consumption shall be equivalent to the net electricity generated from landfill gas by the project activity.

14.2.2.1 Calculation of baseline electricity emissions

Baseline emissions associated with electricity generation shall be calculated using the general approach of TOOLo5. The calculation accounts for the quantity of electricity displaced, the emission factor of the corresponding source and, where applicable, technical transmission and distribution losses.

Where more than one baseline electricity source is displaced, emissions shall be calculated for each source and aggregated for year y.

The calculation shall be performed using the following equation:

$$BE_{EC,y} = \sum_k [EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})] \quad \text{Equation 18}$$

Where:

$BE_{EC,y}$	Baseline emissions associated with electricity generation in year y; tCO ₂ /yr.
$EC_{BL,k,y}$	Amount of electricity that would have been consumed from baseline source k in year y, equivalent to eligible net electricity generated from landfill gas; MWh/yr.
$EF_{EF,k,y}$	Electricity generation emission factor for baseline source k in year y; tCO ₂ /MWh.
$TDL_{k,y}$	Average technical transmission and distribution losses applicable to electricity source k in year y; dimensionless.
k	Electricity sources identified in the baseline scenario.

Source: CDM TOOLo5, version 03.0, Equation (2).

Net electricity generation from landfill gas shall be determined from monitored electricity generation, considering the measurement boundaries and applicable requirements of TOOLo5.

Generated electricity that does not demonstrably displace electricity from an eligible baseline source shall not be included in the calculation.

Where the project activity does not include electricity generation, this baseline emission component shall be zero.

14.2.2.2 Determination of the baseline electricity emission factor

The electricity generation emission factor shall be determined according to the baseline supply configuration and the applicable procedures of TOOLo5.

The Project Holder shall identify which of the following situations applies:

- a) Electricity supplied exclusively by the electricity grid.
- b) Electricity supplied by fossil-fuel-fired captive power plants not connected to the grid.
- c) Electricity supplied by a combination of the grid and fossil-fuel-fired captive power plants.

For grid electricity, the emission factor may be determined using the combined margin approach established in the CDM methodological tool “Tool to calculate the emission factor for an electricity system”, or another option expressly allowed by TOOLo5 under its conditions of application.

For electricity supplied by fossil-fuel-fired captive power plants, the emission factor shall be determined under the applicable TOOLo5 procedures, considering fuel consumption, net calorific values, CO₂ emission factors and electricity generation. Where baseline equipment produces both electricity and heat, the relevant provisions for allocating emissions between the two energy outputs shall apply.

Where electricity is supplied by both the grid and captive power plants, the applicable case and corresponding conservative emission factor shall be selected in accordance with TOOLo5.

The selected approach, supporting data and baseline electricity supply configuration shall be documented in the Project Document and applied consistently throughout the relevant period, subject to applicable baseline reassessment requirements.

14.2.2.3 Transmission and distribution losses

Technical transmission and distribution losses shall be determined in accordance with TOOLo5.

For grid-supplied electricity, the applicable loss factor shall be obtained using permitted national data or conservative default values, subject to the relevant conditions.

For electricity supplied exclusively by captive power plants not connected to the grid, the transmission and distribution loss factor shall be zero, in accordance with the applicable TOOLo5 procedure.

Only technical losses shall be considered. Commercial losses, electricity theft and other non-technical losses shall be excluded.

14.2.2.4 Monitoring of electricity generation

Net electricity generated from landfill gas shall be continuously monitored using electricity meters installed at the appropriate measurement points.

Where electricity is supplied to the grid, monitoring procedures shall determine net exports. Where electricity is supplied to captive electricity consumers, the corresponding quantities shall be measured at delivery points, in accordance with TOOLo5.

Where electricity is supplied both to the grid and to captive electricity consumers, the quantities shall be identified separately and shall not be accounted for more than once.

Electricity meters shall be maintained, tested and calibrated in accordance with the applicable requirements of TOOL05 and the BioCarbon Monitoring, Reporting and Verification Tool.

Monitoring records shall provide sufficient information to establish electricity generated, supplied and consumed, as applicable, and to verify the consistency of the electricity balance.

Project emissions associated with electricity consumption shall be accounted for separately using the project emission procedures. Electricity quantities shall be reconciled to prevent double counting between baseline electricity displacement and project electricity consumption.

14.2.2.5 Conservative treatment and applicable requirements

The selection of baseline electricity sources, emission factors and monitoring procedures shall comply with the applicable conditions of ACM0001 and TOOL05.

Where more than one calculation option is permitted, the selected option shall satisfy the corresponding conservativeness requirements. Uncertainty associated with monitored quantities and emission factors shall be assessed in accordance with the BioCarbon Uncertainty Management Tool.

Emission reductions associated with electricity generation shall be eligible only where the corresponding displacement is demonstrated and the requirements of the BioCarbon Avoiding Double Counting Tool are met.

14.2.3 Baseline emissions associated with heat generation

Baseline emissions associated with heat generation shall be quantified where recovered landfill gas is used to generate heat that displaces heat which, under the baseline scenario, would have been produced using fossil fuels.

This component applies to heat generated from landfill gas in boilers, air heaters, glass-melting furnaces and brick kilns, subject to the applicability conditions of this methodology and ACM0001.

The baseline heat generation system and corresponding fossil fuel shall be identified in accordance with the baseline scenario determined for the project activity. The selected fuel shall be technically available, and applicable supply constraints shall be considered when determining the baseline emission factor.

Baseline emissions shall be calculated using the amount of methane destroyed in heat generation equipment, the net calorific value of methane, the ratio of project to baseline equipment efficiencies, and the CO₂ emission factor of the displaced fossil fuel.

Where more than one eligible heat generation unit is included, the calculation shall be performed for each unit and the results aggregated for year y.

Baseline emissions associated with heat generation in year y shall be calculated as follows:

$$BE_{HG,y} = NCV_{CH_4} \times \sum_{j=1}^n (R_{efficiency,j,y} \times F_{CH_4,HG,dest,j,y} \times EF_{CO_2,BL,HG,j}) \quad \text{Equation 19}$$

Where:

$BE_{HG,y}$	Baseline emissions associated with heat generation in year y; tCO ₂ /yr.
NCV_{CH_4}	Net calorific value of methane under reference conditions; TJ/t CH ₄ .
$R_{efficiency,j,y}$	Ratio of project to baseline efficiencies for heat generation equipment type j in year y; dimensionless.
$F_{CH_4,HG,dest,j,y}$	Amount of landfill gas methane destroyed for heat generation by equipment type j in year y; t CH ₄ /yr.
$EF_{CO_2,BL,HG,j}$	CO ₂ emission factor of the fossil fuel used for baseline heat generation by equipment type j; tCO ₂ /TJ.
j	Type of heat generation equipment: boilers, air heaters, glass-melting furnaces or brick kilns.
n	Number of different heat generation equipment units used in the project activity.

The net calorific value of methane shall be 0.0504 TJ/t CH₄, in accordance with ACM0001.

The baseline fossil fuel emission factor shall be determined using the lower bound of the 95% confidence interval for the applicable default emission factor presented in Table 1.4, Chapter 1, Volume 2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, in accordance with ACM0001.

Where the project activity does not include eligible heat generation, this baseline emission component shall be zero.

14.2.3.1 *Determination of the project and baseline efficiency ratio*

The ratio between project and baseline heat generation efficiencies shall be determined for each eligible heat generation equipment type.

This adjustment ensures that baseline emissions do not exceed the amount attributable to the fossil fuel energy that would have been required to provide the corresponding heat generation service. The ratio shall not exceed one.

The efficiency ratio shall be calculated as follows:

$$R_{efficiency,j,y} = \min \left\{ 1; \frac{\eta_{HG,PJ,j,y}}{\eta_{HG,BL,j}} \right\} \quad \text{Equation 20}$$

Where:

$R_{efficiency,j,y}$	Ratio of the project and baseline efficiency of heat generation equipment type j in year y; dimensionless.
$\eta_{HG,PJ,j,y}$	Efficiency of heat generation equipment type j used in the project activity in year y; dimensionless.
$\eta_{HG,BL,j}$	Efficiency of heat generation equipment type j used in the baseline; dimensionless.
j	Heat generation equipment type, comprising boilers, air heaters, glass melting furnaces or brick-firing kilns.

Baseline efficiency shall be determined using the CDM methodological tool “Determining the baseline efficiency of thermal or electric energy generation systems”.

Project equipment efficiency shall be determined using one of the options established in ACM0001: measured efficiency, manufacturer information or the 60% default value.

Where efficiency is measured, recognized technical standards shall be applied and the procedures and results documented. Efficiency shall be monitored annually in accordance with the applicable provisions of ACM0001.

14.2.3.2 Determination of methane destroyed in heat generation equipment

The amount of methane destroyed for heat generation shall be determined separately for each eligible item of equipment, considering the quantity of methane supplied and the corresponding destruction fraction.

For boilers, air heaters and glass-melting furnaces, the calculation shall use the default destruction fractions established in ACM0001. This procedure may also be applied to intermittently operated brick kilns.

The amount of methane destroyed by heat generation equipment type j in year y shall be calculated as follows:

$$F_{CH_4,HG,dest,j,y} = f_{d_{CH_4,HG,j,default}} \times F_{CH_4,HG,j,y} \quad \text{Equation 21}$$

Where:

$F_{CH_4,HG,dest,j,y}$	Amount of landfill gas methane destroyed for heat generation by equipment type j in year y; t CH ₄ /yr.
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$fd_{CH_4,HG,j,default}$	Default fraction of methane destroyed when used for heat generation in equipment type j; dimensionless.
$F_{CH_4,HG,j,y}$	Amount of landfill gas methane used for heat generation by equipment type j in year y; t CH ₄ /yr.

The following default methane destruction fractions established in Table 4 of ACM0001 shall apply:

Heat generation equipment	Methane destruction fraction
Boilers	1.0
Air heaters	1.0
Glass melting furnaces	1.0
Intermittent brick kilns	0.9

The amount of methane used for heat generation shall be determined using the CDM methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, following the requirements of Section 5.4.1.1 of ACM0001.

Methane quantities shall correspond to actual operation of the heat generation equipment. No methane destruction shall be credited during periods when the equipment is not operating.

14.2.3.3 Determination of methane destroyed in brick kilns using hourly measurements

For brick kilns, ACM0001 provides an alternative procedure based on hourly methane flows and oxygen concentration in the kiln exhaust gases.

This procedure shall apply to continuously operated brick kilns. For intermittently operated kilns, either the default destruction fraction procedure in Equation (21) or the following hourly procedure may be selected, in accordance with ACM0001.

The annual amount of methane destroyed in brick kilns shall be calculated as follows:

$$F_{CH_4,HG,dest,j,y} = \sum_{h=1}^{8760} (fd_{CH_4,kiln,h} \times F_{CH_4,HG,kiln,h}) \quad \text{Equation 22}$$

Where:

$F_{CH_4,HG,dest,j,y}$	Amount of landfill gas methane destroyed for heat generation by the brick kiln in year y; t CH ₄ /yr.
$fd_{CH_4,kiln,h}$	Fraction of methane destroyed when used for heat generation in the brick kiln during hour h; dimensionless.
$F_{CH_4,HG,kiln,h}$	Amount of landfill gas methane used for heat generation by the brick kiln during hour h; t CH ₄ /h.

h Hour of the year.

The methane destruction fraction shall equal 1 when the average volumetric oxygen fraction in the kiln exhaust gases during hour h is greater than zero. Otherwise, it shall equal zero.

The average volumetric oxygen fraction shall be determined for the corresponding kiln exhaust gas stream and expressed as the volume of oxygen divided by the volume of the gaseous stream.

Hourly methane flows shall be determined using the CDM methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, applying the relevant requirements of Section 5.4.1.1 of ACM0001.

Methane mass flow shall be expressed on an hourly basis and aggregated in accordance with Equation (22).

14.2.3.4 Monitoring and applicability requirements

The Project Holder shall monitor methane supplied to each heat generation unit, the operating conditions of each unit and the parameters required to determine the applicable destruction fraction and efficiency ratio.

Baseline emissions associated with heat generation shall be determined in compliance with the measurement, monitoring and data quality requirements established in ACM0001 and the CDM methodological tools cited in this subsection.

The Project Holder shall document the baseline fossil fuel, baseline equipment efficiency, project equipment efficiency and the applicable methane destruction procedure.

Where heat generation equipment existed before project implementation, its remaining useful life and the applicable baseline reassessment requirements shall be addressed in accordance with ACM0001 and the relevant BioCarbon provisions.

Uncertainty and conservative adjustments shall be assessed under the BioCarbon Uncertainty Management Tool. A single methane flow or displaced energy service shall not produce duplicate reductions under different components of this methodology.

14.2.4 Baseline emissions associated with natural gas utilization

Baseline emissions associated with natural gas utilization shall be quantified where recovered landfill gas is supplied to consumers through a natural gas distribution network, a dedicated pipeline or trucks transporting compressed or liquefied landfill gas.

In accordance with ACM0001, the baseline scenario for these activities shall be the displacement of natural gas. The calculation shall not assume displacement of a different fossil fuel with a higher emission factor.

The amount of methane supplied through each eligible distribution system shall be determined separately using monitored landfill gas flows. Corresponding baseline emissions shall be calculated from the energy content of methane and the CO₂ emission factor applicable to natural gas.

Where the project activity does not include eligible displacement of natural gas, this baseline emission component shall be zero.

14.2.4.1 Calculation of baseline emissions associated with natural gas utilization

Baseline emissions shall be calculated from the amount of methane contained in landfill gas supplied to a natural gas distribution network, a dedicated pipeline or trucks, multiplied by the methane net calorific value and the average CO₂ emission factor of the displaced natural gas.

The calculation shall be performed annually using the following equation:

$$BE_{NG,y} = 0.0504 \times F_{CH_4,NG,y} \times EF_{CO_2,NG,y} \quad \text{Equation 23}$$

Where:

$BE_{NG,y}$	Baseline emissions associated with natural gas utilization in year y; tCO ₂ e/yr.
$F_{CH_4,NG,y}$	Amount of landfill gas methane sent to the natural gas distribution network, dedicated pipeline or trucks in year y; t CH ₄ /yr.
$EF_{CO_2,NG,y}$	Average CO ₂ emission factor of natural gas in the network, dedicated pipeline or trucks in year y; tCO ₂ e/TJ.
0.0504	Net calorific value of methane under reference conditions; TJ/t CH ₄ .

The net calorific value of methane shall be 0.0504 TJ/t CH₄, as established in ACM0001.

The emission factor shall correspond to the natural gas displaced by the project activity and shall be determined in accordance with the procedure described below.

14.2.4.2 Determination of the natural gas emission factor

The average CO₂ emission factor of natural gas shall be determined using the CDM methodological tool “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”, as required by ACM0001.

The Project Holder shall identify the applicable natural gas supply configuration and document the data and assumptions used to determine the emission factor.

The selected emission factor shall be consistent with the requirements of the cited CDM tool and the natural gas supply configuration identified in the baseline scenario.

Where project-specific or national data are used, their selection and application shall comply with the data hierarchy and calculation procedures permitted by the applicable tool.

14.2.4.3 Determination and monitoring of methane supplied

The amount of methane supplied to the natural gas distribution network, dedicated pipeline or trucks shall be determined ex post using the CDM methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”.

The calculation shall follow the relevant requirements of Section 5.4.1.1 of ACM0001, including measurement of gas flow and methane concentration.

Where recovered landfill gas is distributed through more than one system, methane quantities shall be identified separately and included only once in the annual calculation.

Monitoring procedures shall identify the applicable measurement points and provide sufficient records to determine the amount of methane supplied during each monitoring period.

14.2.4.4 Treatment of distribution emissions and prevention of double counting

Project emissions associated with processing and supplying landfill gas shall be accounted for under the project emission procedures of this methodology.

In particular, emissions associated with transportation of compressed or liquefied landfill gas by truck, including methane losses during transport, and emissions associated with physical methane leaks from dedicated pipelines shall be determined using the corresponding procedures of ACM0001.

Additional leakage emissions shall be assessed in accordance with the BioCarbon Leakage Management Tool without duplicating emissions already included in the project emissions calculation.

The same quantity of recovered methane shall not be credited under more than one utilization pathway. Reductions from natural gas displacement shall be distinguished from those arising from electricity or heat generation, in accordance with the BioCarbon Avoiding Double Counting Tool.

Uncertainty and conservative adjustments shall be addressed in accordance with the BioCarbon Uncertainty Management Tool.

14.3 Project emissions

Project emissions shall include GHG emissions attributable to the operation of landfill gas recovery, destruction and utilization systems. In accordance with ACM0001 Version 19.0, these emissions include electricity consumption, fossil fuel combustion, transportation of compressed or liquefied landfill gas by truck, and methane leaks from dedicated pipelines.

Each component shall be quantified separately, where applicable. Emissions associated with methane not destroyed by flaring are already included in the determination of methane destroyed and shall not be deducted again.

Project emissions in year y shall be calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y} \quad \text{Equation 24}$$

Where:

PE_y	Total project emissions in year y; tCO ₂ e/yr.
$PE_{EC,y}$	CO ₂ emissions from electricity consumption attributable to the project activity in year y; tCO ₂ /yr.
$PE_{FC,y}$	CO ₂ emissions from fossil fuel combustion for purposes other than electricity generation in year y; tCO ₂ /yr.
$PE_{DT,y}$	Emissions from distribution of compressed or liquefied landfill gas by truck in year y; tCO ₂ e/yr.
$PE_{SP,y}$	Emissions associated with physical methane leaks from dedicated pipelines supplying landfill gas to consumers in year y; tCO ₂ e/yr.

A component not applicable to the project activity shall have a value of zero. Methane emissions occurring during truck transport and pipeline distribution are included in the corresponding project emission components and shall not be deducted again as leakage.

14.3.1 Emissions from electricity consumption

Project emissions from electricity consumption shall include electricity used for extraction, pumping, treatment, compression and liquefaction of landfill gas, as well as operation of associated facilities.

Electricity consumption shall be determined for each relevant source. Where an existing gas recovery and destruction system consumed electricity in the baseline, only incremental consumption attributable to the project shall be accounted for, in accordance with ACM0001.

Emissions shall be calculated using the following equation:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y}) \quad \text{Equation 25}$$

Where:

$PE_{EC,y}$	Project emissions from electricity consumption in year y; tCO ₂ /yr.
$EC_{PJ,j,y}$	Electricity consumed by project source j in year y; MWh/yr.

$EF_{EF,j,y}$	Electricity generation emission factor for the supply to source j in year y; tCO ₂ /MWh.
$TDL_{j,y}$	Average technical transmission and distribution losses applicable to source j in year y; dimensionless.
j	Electricity consumption sources attributable to the project activity.

The electricity emission factor shall reflect the source of supply for project equipment: the electricity grid, fossil-fuel-fired captive power plants or a combination of both.

For grid electricity, the combined margin factor or conservative default value permitted by TOOL05 shall be applied. For fossil-fuel-fired captive generation, the factor shall reflect relevant fuel consumption and electricity generation, accounting for allocation of emissions to useful heat where cogeneration occurs.

Where both the grid and captive generation may be affected, the applicable source and conservative emission factor shall be selected according to the operating configuration. The selection shall distinguish changes affecting grid supply only, captive generation only or both.

Technical transmission and distribution losses shall be included where applicable. Non-technical losses shall not be considered.

Electricity consumption already deducted when determining eligible net electricity generation shall not be deducted again as project emissions.

14.3.2 Emissions from fossil fuel combustion

Emissions from fossil fuel combustion shall include incremental fuel consumption for purposes other than electricity generation, including auxiliary equipment, gas treatment facilities, emergency operations and on-site transport.

Where an existing landfill gas management system consumed fossil fuels in the baseline, only the net increase attributable to the project shall be included.

For each combustion process j, CO₂ emissions shall be determined as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \quad \text{Equation 26}$$

Where:

$PE_{FC,j,y}$	CO ₂ emissions from fossil fuel combustion in process j in year y; tCO ₂ /yr.
$FC_{i,j,y}$	Amount of fossil fuel type i consumed in process j during year y; mass or volume units/yr.
$COEF_{i,y}$	CO ₂ emission coefficient of fossil fuel type i in year y; tCO ₂ per unit of mass or volume.

- i Types of fossil fuels used in process j.
- j Fossil fuel combustion processes attributable to the project.

The project emission component $PE_{FC,y}$ shall include the emissions calculated for all applicable combustion processes.

The CO₂ emission coefficient may be determined from the carbon content of the fuel or from its net calorific value and CO₂ emission factor.

Where carbon content is used and fuel consumption is expressed in units of mass:

$$COEF_{i,y} = \omega_{C,i,y} \times \frac{44}{12} \quad \text{Equation 27}$$

Where fuel consumption is expressed in units of volume:

$$COEF_{i,y} = \omega_{C,i,y} \times \rho_{i,y} \times \frac{44}{12} \quad \text{Equation 28}$$

Alternatively, the coefficient may be determined using the net calorific value:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO_2,i,y} \quad \text{Equation 29}$$

Where:

$\omega_{C,i,y}$	Weighted-average mass fraction of carbon in fuel type i; t C per unit mass of fuel.
$\rho_{i,y}$	Weighted-average density of fuel type i; mass units per unit volume.
$NCV_{i,y}$	Weighted-average net calorific value of fuel type i; GJ per unit mass or volume.
$EF_{CO_2,i,y}$	Weighted-average CO ₂ emission factor of fuel type i; tCO ₂ /GJ.

The carbon-content approach shall be preferred where the necessary information is available. Otherwise, the net-calorific-value approach may be used with representative fuel-specific data or applicable IPCC default values, in accordance with the data selection and conservative treatment requirements of TOOLo3.

14.3.3 Emissions from transportation of compressed or liquefied landfill gas by truck

Where recovered landfill gas is compressed or liquefied and transported to consumers by trucks, project emissions shall include both transport-related CO₂ emissions and methane losses during transportation.

These components shall be calculated separately and aggregated as follows:

$$PE_{DT,y} = PE_{TR,y} + PE_{leaks,y} \quad \text{Equation 30}$$

Where:

$PE_{DT,y}$	Project emissions from distribution of compressed or liquefied landfill gas by truck in year y; tCO ₂ e/yr.
$PE_{TR,y}$	CO ₂ emissions from transporting compressed or liquefied landfill gas in year y; tCO ₂ /yr.
$PE_{leaks,y}$	Methane emissions from losses during transport in year y; tCO ₂ e/yr.

Transportation emissions

CO₂ emissions associated with transportation shall be determined using monitored vehicle fuel consumption or conservative default emission factors.

Where monitored fuel consumption is used, emissions shall be calculated using Equation (26), treating the gas transport vehicles as combustion processes. Fuel consumption shall include both outbound and return trips.

Alternatively, transportation emissions may be calculated from the amount transported, the round-trip distance and the applicable default emission factor:

$$PE_{TR,m} = \sum_f D_{f,m} \times FR_{f,m} \times EF_{CO_2,f} \times 10^{-6} \quad \text{Equation 31}$$

Where:

$PE_{TR,m}$	Project emissions from freight transport during monitoring period m; tCO ₂ .
$D_{f,m}$	Round-trip distance for transport activity f during monitoring period m; km.
$FR_{f,m}$	Amount of compressed or liquefied landfill gas transported in activity f during monitoring period m; t.
$EF_{CO_2,f}$	Default transport emission factor for activity f; gCO ₂ /t·km.
f	Freight transport activities.

Where this option is selected, the following TOOL12 default factors shall apply: 245 gCO₂/t·km for vehicles with a gross vehicle weight of up to 26 tonnes, and 129 gCO₂/t·km for vehicles with a gross vehicle weight exceeding 26 tonnes.

The same calculation option shall be applied consistently to each identified transport activity during the relevant period. Emissions from monitoring periods within year y shall be aggregated to determine $PE_{TR,y}$.

Methane losses during transport

Methane emissions during transportation of compressed or liquefied landfill gas shall be determined from the difference between methane loaded for transport and methane delivered to consumers.

$$PE_{leaks,y} = GWP_{CH_4} \times (F_{CH_4,NGTR,y} - F_{CH_4,NG-cons,y}) \quad \text{Equation 32}$$

Where:

$PE_{leaks,y}$	Methane emissions during transport in year y; tCO ₂ e/yr.
GWP_{CH_4}	Global warming potential of methane required by the BCR Standard; tCO ₂ e/t CH ₄ .
$F_{CH_4,NGTR,y}$	Amount of landfill gas methane loaded onto trucks in year y; t CH ₄ /yr.
$F_{CH_4,NG-cons,y}$	Amount of methane delivered to consumers by truck in year y; t CH ₄ /yr.

Methane quantities shall be determined using gas flows and methane concentrations measured at the relevant loading and delivery points.

These emissions form part of $PE_{DT,y}$ and shall not be deducted again in the separate leakage assessment.

14.3.4 Emissions from landfill gas supply through dedicated pipelines

Where recovered gas is supplied to consumers through a dedicated pipeline, emissions associated with physical leaks shall be calculated using the energy content of the methane supplied and the applicable default leakage emission factor.

$$PE_{SP,y} = 0.0504 \times DEF_{TSP,y} \times F_{CH_4,NG,y} \quad \text{Equation 33}$$

Where:

$PE_{SP,y}$	Project emissions associated with physical leaks from dedicated pipelines in year y ; tCO ₂ e/yr.
$DEF_{TSP,y}$	Default emission factor for physical leaks during landfill gas supply through a dedicated pipeline; tCO ₂ e/TJ.
$F_{CH_4,NG,y}$	Amount of methane supplied to consumers through the dedicated pipeline in year y ; t CH ₄ /yr.
0.0504	Net calorific value of methane under reference conditions; TJ/t CH ₄ .

The default emission factor for leakage shall be 2.2 tCO₂e/TJ, in accordance with ACM0001 Version 19.0, based on the CDM tool “Upstream leakage emissions associated with fossil fuel use”.

The methane flow used in Equation (33) shall include only the quantity supplied through the corresponding dedicated pipeline. Methane transported by truck or supplied through other arrangements shall not be included in this component.

These emissions shall be included in $PE_{SP,y}$ and shall not be accounted for again in the separate leakage assessment.

14.4 Leakage emissions

Leakage emissions comprise increases in GHG emissions occurring outside the defined project boundary that are attributable to implementation of the project and have not been accounted for as project emissions.

All project activities shall identify and assess potential leakage in accordance with the BioCarbon Leakage Management Tool. Material leakage shall be quantified or conservatively accounted for and deducted from emission reductions.

14.4.1 Identification of leakage sources

The Project Holder shall assess potential leakage arising from:

- Changes in waste management or landfill gas recovery activities outside the project boundary that are demonstrably caused by the project activity.
- Displacement of existing landfill gas uses or other energy supply arrangements that results in increased emissions elsewhere.
- Additional upstream or downstream activities attributable to the treatment, processing, distribution or utilization of landfill gas that are not included in project emissions.
- Other identifiable displacement or market effects that may increase emissions outside the project boundary.

Only leakage mechanisms supported by a plausible causal relationship with the project activity shall be considered. Each identified source shall be documented, including its expected magnitude and likelihood.

14.4.2 Leakage assessment and materiality

Each identified leakage source shall be assessed in terms of its likelihood, expected magnitude, duration and potential effect on net emission reductions.

The assessment shall follow the risk classification established in the BioCarbon Leakage Management Tool: negligible, low, moderate or high.

For the quantitative assessment of materiality:

- a) Estimated leakage below 2% of emission reductions before leakage may be considered immaterial, subject to appropriate documented justification.
- b) Estimated leakage between 2% and 5% shall require a more detailed assessment and conservative justification.
- c) Estimated leakage of 5% or more shall generally be considered material.

Materiality shall not be determined solely using these thresholds where project-specific evidence indicates a significant displacement risk.

14.4.3 Quantification and conservative treatment

Material and measurable leakage shall be quantified using verifiable activity data, appropriate emission factors and conservative assumptions.

Where direct measurement is not feasible, the Project Holder shall use documented conservative estimation methods based on the displaced activity, relevant market or operating data, or other technically justified evidence.

Where material leakage cannot be quantified reliably, an appropriate conservative deduction or restriction on creditable emission reductions shall be applied in accordance with the BioCarbon Leakage Management Tool.

Leakage determined to be negligible or immaterial may be excluded from quantitative deductions where the assessment is properly documented and independently validated.

The following emissions shall not be accounted for again as leakage:

- a) Methane emissions from incomplete flaring already reflected in the determination of methane destroyed.
- b) Emissions from electricity consumption and fossil fuel combustion already included in project emissions.
- c) Emissions from transportation of landfill gas by truck already included in $PE_{DT,y}$.

d) Methane leaks from dedicated pipelines already included in $PE_{SP,y}$.

All material leakage emissions and applicable conservative deductions shall be incorporated into the calculation of net GHG emission reductions under Section 14.5.

14.4.4 Monitoring and reassessment

The Project Holder shall monitor the parameters necessary to quantify material leakage or support the continued applicability of conservative adjustments.

Leakage shall be reassessed when changes in project scale, operating conditions, gas distribution arrangements, project boundaries or other relevant circumstances may affect the identified risks.

Leakage identification, materiality assessment, quantification and treatment shall be documented in the Project Document and the corresponding monitoring reports.

Emission reductions for which material leakage has not been appropriately quantified or conservatively addressed shall not be eligible for credit issuance.

14.5 Net GHG emission reductions

Net GHG emission reductions shall be determined annually by deducting project emissions and material leakage from baseline emissions.

ACM0001 Version 19.0 calculates emission reductions as the difference between baseline and project emissions. BCR0021 adds a leakage deduction to comply with the BioCarbon Leakage Management Tool.

Net GHG emission reductions in year y shall be calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation 34}$$

Where:

ER_y	Net GHG emission reductions in year y , before uncertainty adjustments; tCO ₂ e/yr.
BE_y	Baseline emissions in year y , calculated according to Section 14.2; tCO ₂ e/yr.
PE_y	Project emissions in year y , calculated according to Section 14.3; tCO ₂ e/yr.
LE_y	Material leakage emissions and applicable conservative deductions in year y , determined under Section 14.4; tCO ₂ e/yr.

The calculation shall include all applicable emission sources without double counting. Methane emissions already reflected in destruction efficiency calculations and emissions accounted for as project emissions shall not be deducted again as leakage.

Where a documented assessment identifies no material leakage, LE_y shall be zero.

Annual results shall be aggregated for the monitoring period, retaining negative annual results where they occur. Only positive net reductions, after the applicable uncertainty and conservativeness adjustments, shall be eligible for credit issuance.

The final eligible quantity shall be determined in accordance with Section 14.6.

14.6 Uncertainty and conservative adjustments

The Project Holder shall assess and manage uncertainty in accordance with the BioCarbon Conservative Approach and Uncertainty Management Tool.

The assessment shall cover the combined uncertainty of net GHG emission reductions, including, where applicable:

- a) Measurements of landfill gas flow and methane concentration.
- b) Methane destruction efficiencies and landfill gas oxidation factors.
- c) Baseline methane destruction and historical operating data.
- d) Electricity and thermal energy generation, equipment efficiencies and energy displacement factors.
- e) Fossil fuel consumption, emission factors and natural gas distribution parameters.
- f) Project emissions and estimated material leakage.

Uncertainty shall be quantified using the applicable Tier 1 or Tier 2 procedures and expressed as the relative half-width of a two-sided 90% confidence interval.

Where the relative half-width exceeds 30%, the percentage in excess of that threshold shall be deducted from estimated net GHG emission reductions as a conservative adjustment, in accordance with Section 11.2 of the BioCarbon Uncertainty Management Tool.

The exemption under Section 11.3 of that tool may be applied only where full compliance with its conditions concerning consistency with national GHG inventory data and the reference scenario is demonstrated and documented.

Uncertainty that cannot be reliably represented by statistical analysis shall be addressed through conservative assumptions, parameter selection or other measures required by the applicable tool.

The uncertainty assessment, supporting data, calculations and conservative adjustments shall be documented in the Project Document and monitoring reports.

The final number of Verified Carbon Credits (VCCs) eligible for issuance shall be rounded down to the nearest whole tonne of CO₂ equivalent after all required adjustments have been applied.

15 Monitoring requirements

15.1 General requirements

The Project Holder shall implement a monitoring system that enables determination of baseline emissions, project emissions, leakage and net GHG emission reductions, in accordance with the procedures established in this methodology and the BioCarbon Monitoring, Reporting and Verification Tool.

Depending on the eligible activities, the system shall cover measurement of landfill gas flows and methane content, operation of destruction and utilization equipment, energy generation and consumption, auxiliary fuel consumption and amounts of gas supplied to third parties.

Measurement points shall enable identification of the methane recovered, distributed, destroyed or utilized by each device, together with corresponding emissions and losses. Where several items of equipment share instruments, the measurement and operation conditions in Section 14.2.1 shall be met.

Parameters are classified as data available at validation and data monitored during operation. Applicable sources, frequencies and procedures are presented in the tables in this section. Parameters not relevant to a technology configuration may be identified as not applicable, with appropriate justification.

The Project Holder shall maintain verifiable records of measurements, calculations, calibrations, maintenance, operating interruptions, and treatment of missing or invalid data. Quantities used for calculations shall be reconcilable with original records and actual operating conditions of the facilities.

15.2 Data and parameters available at validation

The parameters in Table 3 shall be defined and justified in the Project Document before use. Default values originating from the CDM shall be applied only under the specified conditions; factors required by the BCR Standard shall prevail where applicable.

Table 3. Data and parameters available at validation

Data or parameter	Unit	Source or procedure	Frequency or condition
OX_{top_layer}	Dimensionless	Methane oxidation fraction in the SWDS cover. Default value of 0.1 according to ACM0001 Version 19.0. Its use shall be supported by	Defined ex ante; reviewed when material changes occur in cover

Data or parameter	Unit	Source or procedure	Frequency or condition
		documented characterization of the site cover. Any conservative adjustment shall be justified under Section 14.2.1 and the applicable baseline tool.	characteristics or relevant technical evidence becomes available.
$F_{CH_4,BL,x-1}$	t CH ₄ /yr	Methane captured and destroyed by the existing system during the year preceding the project start date; verifiable operating records.	Case 3 with historical data.
$F_{CH_4,x-1}$	t CH ₄ /yr	Methane generated at the landfill during the preceding year; estimated using the applicable SWDS methane generation model.	Case 3: adjustment of historical data.
GWP_{CH_4}	tCO ₂ e/t CH ₄	Global warming potential of methane established in the applicable BCR Standard.	All conversions of methane to CO ₂ e.
NCV_{CH_4}	TJ/t CH ₄	Net calorific value of methane: 0.0504, according to ACM0001.	Heat recovery, natural gas and pipelines.
η_{PJ}	Dimensionless	Expected collection efficiency: system specifications or the default value of 0.50, according to ACM0001.	Ex ante estimates only.
$\eta_{HG,BL,j}$	Dimensionless	Baseline thermal equipment efficiency, determined from the reference system and the applicable technical procedure.	Displaced heat generation.
$EF_{CO_2,BL,HG,j}$	tCO ₂ /TJ	Baseline fossil fuel emission factor: lower bound of the 95% interval in IPCC 2006, Vol. 2, Ch. 1, Table 1.4.	Displaced heat generation.
$f_{dCH_4,HG,j,default}$	Dimensionless	Destruction fraction: boilers 1.0; air heaters 1.0; glass-melting furnaces 1.0; intermittent brick kilns 0.9.	Eligible thermal equipment using default factors.
$DEF_{TSP,y}$	tCO ₂ e/TJ	Default loss factor for dedicated pipelines: 2.2, according to ACM0001 Version 19.0.	Distribution via dedicated pipeline.
$EF_{CO_2,f}$	gCO ₂ /(t·km)	TOOL12 factors for road transport: 245 for gross vehicle weight ≤26 t and 129 for >26 t.	Default-factor option for trucks only.

The displaced energy sources, methane destruction obligations, condition of the existing collection system and historical landfill information shall also be documented during

validation. Parameters whose values must be updated during operation are included in the monitoring tables.

15.3 Monitored data and parameters

Tables 4 to 6 establish the records required to calculate the applicable components of Section 14. Annual aggregated values shall remain traceable to the original measurements and operating periods.

Table 4. Monitored data: recovered gas, destruction and operation

Data or parameter	Unit	Source or procedure	Frequency or condition
SWDS management	—	Original design, disposal and management practices, technical specifications and regulatory requirements; record and justify changes.	Annually.
$F_{CH_4,BL,R,y}$; $\rho_{reg,y}$	t CH ₄ /yr; dimension less	Methane destruction obligations and mandatory fraction; permits, contracts, safety and odor-control requirements.	Annually and following regulatory changes.
$F_{CH_4,PJ,capt,y}$	t CH ₄ /yr	Flow captured immediately downstream of the extraction system or sum of flows supplied to permitted uses without adjustment for operating hours, under Section 14.2.1.4.	Hourly measurement and annual aggregation.
CH ₄ flow rate and fraction	m ³ /h or kg/h; dimension less	Measurement of each eligible stream, identifying dry/wet basis; composition, moisture, temperature and pressure where applicable.	Continuous; mass flow calculated hourly.
$F_{CH_4,sent,flare,y}$	t CH ₄ /yr	Amount of methane supplied to each flare; meters in the feed stream.	Continuous; one-minute resolution for flare calculations.
$\eta_{flare,m}$; $PE_{flare,y}$	Dimension less; tCO ₂ e/yr	Flame detectors; flow rate, temperature and manufacturer operating conditions; measured or default efficiency according to the option selected.	Operating status and calculation by minute; tests according to the option selected.
$O_{j,h}$	0 or 1	Operating status for each device demonstrated by temperature, flame	Hourly, with instantaneous

Data or parameter	Unit	Source or procedure	Frequency or condition
		detection or eligible energy output; no crediting of inactive hours.	records as required by equipment.
$F_{CH_4,EL,y}$; $F_{CH_4,HG,j,y}$	t CH ₄ /yr	Mass flows sent to electricity and heat generation, reconciled with operating hours.	Hourly and annual aggregation.
$\eta_{HG,PJ,j,y}$	Dimensionless	Measured thermal equipment efficiency, manufacturer documentation or the default value of 0.60 permitted under ACM0001.	Annually when measured; fixed-option documentation.
$f_{d_{CH_4,kiln,h}}$; $F_{CH_4,HG,kiln,h}$	Dimensionless; t CH ₄ /h	Destruction fraction and hourly flow in brick kilns based on O ₂ concentration in exhaust gases.	Hourly where the kiln-specific calculation applies.

Table 5. Monitored data: energy and fuels

Data or parameter	Unit	Source or procedure	Frequency or condition
$EG_{PJ,y}$	MWh/yr	Net electricity generation from landfill gas; meters at the relevant generation or delivery points.	Continuous; annual aggregation.
$EC_{PJ,y}$	MWh/yr	Electricity consumed for extraction, treatment, pumping, compression, liquefaction and auxiliary equipment, distinguished by source.	Continuous; annual aggregation.
$EF_{EF,k,y}$; $TDL_{k,y}$	tCO ₂ /MWh; dimensionless	Emission factor of the baseline electricity source and technical transmission and distribution losses.	As required by the update applicable to year y.
$EF_{EF,i,y}$; $TDL_{i,y}$	tCO ₂ /MWh; dimensionless	Electricity supply emission factor for the project and applicable technical losses, consistent with the electricity source used.	By source and monitoring year.
$FC_{i,j,y}$	Mass or volume/yr	Fossil fuel consumption by process; reconciled meters, invoices, inventories and supply records.	Per supply or consumption event; annual aggregation.
$\omega_{C,i,y}$; $\rho_{i,y}$; $NCV_{i,y}$; $EF_{CO_2,i,y}$	As in Section 14.3.2	Carbon content, density, calorific value and emission factor of fuel, according to the selected calculation approach.	By specification/test/source; update if fuel changes.

Data or parameter	Unit	Source or procedure	Frequency or condition
$EF_{CO_2,NG,y}$	tCO ₂ e/TJ	Emission factor of displaced natural gas, obtained from admissible data for the relevant configuration.	By application period and data update.

Table 6. Monitored data: distribution, leakage and uncertainty

Data or parameter	Unit	Source or procedure	Frequency or condition
$F_{CH_4,NG,y}$	t CH ₄ /yr	Methane sent to the natural gas network, dedicated pipeline or trucks; records by destination without duplication.	Continuous for network/pipeline; per batch for trucks.
$F_{CH_4,NG,TR,y}$; $F_{CH_4,NG-cons,y}$	t CH ₄ /yr	Methane loaded onto trucks and delivered to consumers; measurement at loading and unloading points.	Per batch; annual aggregation.
$D_{f,m}$; $F_{f,m}$	km; t	Round-trip distance and quantity of gas transported for each freight transport activity.	Per trip or batch; aggregated by period.
LE_y and material sources	tCO ₂ e/yr	Activity data, factors and conservative estimates for identified leakage mechanisms not included in PE_y	Risk-based; reassess annually and after changes.
Uncertainty and adjustments	% / tCO ₂ e	Instrument accuracy, calibrations, combined uncertainty assessment and required conservative adjustments.	Each monitoring period.

15.4 Specific measurement and operating procedures

15.4.1 Methane measurement and allocation among devices

Methane mass shall be determined from gaseous stream flow and its CH₄ fraction, with corrections for moisture, pressure and temperature where required by the equipment and measurement basis used. It shall be documented whether flow and concentration are measured on a dry or wet basis, together with the reference conditions applied. Continuous measurements shall refer to the same time interval.

Where volumetric flow and methane concentration are expressed on a dry basis, methane mass flow shall be determined by the following equation, in accordance with TOOLo8, Version 03.0:

$$F_{CH_4,t} = V_{t,db} \times v_{CH_4,t,db} \times \rho_{CH_4,t} \quad \text{Equation 35}$$

Where:

$F_{CH_4,t}$	Methane mass flow during interval t; kg CH ₄ /h.
$V_{t,db}$	Volumetric flow of the gaseous stream on a dry basis; m ³ /h.
$v_{CH_4,t,db}$	Volumetric fraction of methane on a dry basis; dimensionless.
$\rho_{CH_4,t}$	Methane density under the measurement conditions; kg/m ³ .
t	Measurement interval.

Methane density shall be determined using the absolute pressure and temperature of the gaseous stream. Where flow or concentration is measured on a wet basis, it shall be converted to a compatible measurement basis before Equation 35 is applied, in accordance with the relevant TOOLo8 procedures.

Measurement conditions, conversions applied and data used shall be documented and verifiable.

Recovered methane intended for destruction or utilization shall be calculated over hourly intervals; for flares, methane flow and combustion conditions shall be assessed at one-minute intervals to determine emissions. Instruments shall identify the stream being recorded and allow the collected flow to be reconciled with flows directed to each use.

For calculation of flare emissions using Equation 5, where the methane mass flow is expressed in kg CH₄/h, the mass supplied in each minute shall be obtained by dividing the average flow corresponding to that minute by 60. The data used shall represent the operating conditions of the respective interval.

A shared meter may be used for several devices only where the operation of all devices is verified and the destruction efficiency of the least efficient device is applied. If a device ceases operation, reductions may be recognized from the remaining devices only where valves automatically prevent gas from entering the inactive device or the design prevents release, and sufficient capacity of the remaining operating devices is demonstrated.

15.4.2 Flare operation and efficiency

Flares shall have flame detection records. For open flares, destruction efficiency shall be 0.50 during minutes when a flame is detected and zero when none is detected. For enclosed flares, a default efficiency of 0.90 may be used only when a flame is present and the flow rate and temperature comply with the manufacturer's operating conditions; efficiency shall be zero for all other minutes. For low-height enclosed flares, the default value shall be reduced by ten percentage points.

Alternatively, for enclosed flares, destruction efficiency may be determined through at least two measurement campaigns during the year, separated by a minimum of six months, applying TOOLo6, Version o4.o, including the conservative deduction of five percentage points.

The selected option and backup conditions for missing data shall be identified before application. Emissions calculated for each flare shall be aggregated without accounting again for methane that was not destroyed.

15.4.3 Electricity and thermal energy generation

Eligible electricity shall be measured as net generation, distinguishing exports, self-consumption and auxiliary consumption. Where the same consumption has already been deducted in determining eligible net electricity, it shall not be deducted again as project emissions.

Operation of each thermal unit shall be demonstrated using the variables permitted for that technology: temperature above the manufacturer's threshold, flame detection or actual generation of the thermal product. Records shall be aggregated hourly; hours without valid evidence of operation shall have an operating status of zero. For brick kilns, only the indicators and procedures in Section 14.2.3 shall apply.

15.4.4 Distribution to third parties

Gas supplied through pipelines, networks and trucks shall be measured at points allowing quantities supplied, quantities actually received and relevant inventory changes to be distinguished. Quantities loaded onto and delivered by trucks shall be reconciled by batch. Transport records shall identify origin, destination, distance, load transported and the corresponding vehicle or service.

15.5 Quality control and treatment of missing data

Gas meters, analyzers, sensors, electricity meters and other instruments shall be maintained and calibrated in accordance with applicable manufacturer specifications and the technical requirements of the selected measurement procedure. Concentration analyzers shall be checked using certified calibration gas standards, including a zero check and at least one measurement point.

For missing data on gas flow or methane concentration, the conservative substitution procedure of TOOLo8, Version o3.o, shall apply under the following conditions: only one of the two variables may be substituted for the same interval; the other variable shall be available and consistent with normal operation, with no deviations greater than 20% from the reference period; moreover, actual methane destruction during the interval shall be demonstrated.

Treatment based on the duration of the data gap shall be as follows:

Table 7. Conservative treatment of missing gas and methane data

Data or parameter	Unit	Source or procedure	Frequency or condition
Less than 6 hours	—	Weighted average of the four hours immediately before and the four hours after the data gap.	Only if all substitution conditions are met.
6 to 24 hours	—	Upper or lower bound of the 95% confidence interval for the 24 hours before and after, whichever is more conservative.	Only if all substitution conditions are met.
More than 24 hours, up to 7 days	—	Upper or lower bound of the 95% confidence interval for the 72 hours before and after, whichever is more conservative.	Only if all substitution conditions are met.
More than 7 days	—	Substitution of missing data is not permitted.	No crediting of unsubstantiated methane destruction.

Where both flow and methane concentration are missing simultaneously, or equipment operation cannot be demonstrated, no methane destruction reductions shall be recognized for the affected interval. Substitution of other parameters and associated uncertainty adjustments shall follow the applicable BioCarbon rules without overestimating reductions.

15.6 Monitoring records and reports

Each monitoring report shall present results disaggregated by site and system, instrument identification and periods covered, gas and energy balances, default parameters, and operating or regulatory changes affecting the baseline scenario.

Where the project includes electricity generation, monitoring reports shall identify installed electrical capacity, expressed in MWe, and any changes in such capacity during the reporting period.

Calculations of baseline and project emissions, leakage mechanisms, excluded or substituted data, uncertainty and conservative adjustments shall be documented. Measurement traceability shall enable reproduction of the Section 14 calculations and differentiation of results among gas uses, avoiding double counting.

Original records, instrument supporting documents, calibration certificates and supporting evidence shall be retained in accordance with the periods and provisions established in the BCR Standard and the BioCarbon MRV Tool.

16 Bibliographic references

The following sources support the technical procedures incorporated into this methodology. BioCarbon documents apply in accordance with the BCR Standard and its validity and transition provisions. CDM references provide the technical basis for the procedures expressly incorporated.

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Document history

Document type. Methodological document. Recovery, destruction and utilization of methane from landfill gas

Version	Date	Description
Public Consultation draft	21 October 2026	Preliminary version for public consultation. Establishes eligibility, baseline, quantification and monitoring requirements for the recovery, destruction and utilization of methane from landfill gas.

Draft for public consultation