GHR003 Methodology for Assessing Methane Recovery from Landfill Gas

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GLOBAL HEAT REDUCTION™

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1. Introduction

This Methodology has been developed for use in connection with the Global Heat Reduction (GHR) Registry (the "Registry), consistent with the requirements of the GHR Registry Standard. It is intended for use in evaluating Projects under selected project types and within geographic regions identified herein.

The Methodology uses the standard nomenclature of "shall" or "must" for required clauses and "should" or "may" for suggested clauses. All documentation and reporting under this methodology must be conducted in English, with translations provided where necessary to accommodate local stakeholders.

2. Methodology Overview

2.1 Methodology Description

This methodology describes the requirements and standards for the installation, expansion, or enhancement of landfill gas (LFG) capture and management systems to qualify for verified credits from the GHR Registry. The primary goal is to achieve methane emission reductions through the capture of landfill gas for flaring or beneficial use, such as energy production.

The methodology is consistent with the methane recovery procedures of the Clean Development Mechanism (CDM) under the United Nations Framework Convention on Climate Change (UNFCCC). Specifically, it draws upon the CDM methane recovery methodology *ACM0001 Large-scale Consolidated Methodology: Flaring or use of landfill gas*[1] and the Climate Action Reserve's *U.S. Landfill Project Protocol Version 6.0*[2].

This methodology is designed to ensure that credits issued represent additional, permanent, independently-verified, and rigorously-quantified reductions in methane emissions. Final approval of a project under this methodology is granted exclusively by the GHR Registry.

2.2 Project Activities Covered by the Methodology

Projects under tis methodology capture methane in landfill gas for destruction or gainful use.

2.3 Eligibility Requirements for Projects under the Methodology

Individual projects are considered eligible to earn credits if they meet all eligibility requirements of the GHR Registry Standard and the project activity meets all of the following conditions:

1. Installing a new LFG capture system in an existing or new (greenfield) solid waste disposal site (SWDS) where no LFG capture system was prior to the implementation of the project activity, and where such a system would not have been installed without the project activity; or
2. Making an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:
    a. The captured LFG was vented or flared prior to the implementation of the project activity, or was used at a lower recovery rate; and
    b. Historical data on the amount of LFG captured and flared or used is available, if the following is true:
        i. The amount of LFG cannot be collected separately from the project system after the implementation of the project activity; and
        ii. The efficiency of the existing active LFG capture system is not impacted by the project system;
3. Flaring the LFG and/or use the captured LFG in any (combination) of the following ways:
    a. Generating electricity;

[1] ACM0001 Large-scale Consolidated Methodology: Flaring or use of landfill gas. Version 19.0. Available at: https://cdm.unfccc.int/UserManagement/FileStorage/HEJ2MD41GB0PUZISL9FNTAYQV3875O
[2] U.S. Landfill Project Protocol Version 6.0. Available at: https://www.climateactionreserve.org/wp-content/uploads/2023/10/U.S._Landfill_Protocol_V6.0_Combined_04132023-1.pdf

   b. Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace;[3] and/or
   c. Supplying the LFG to consumers through a natural gas distribution network;
   d. Supplying compressed/liquefied LFG to consumers using trucks;[4]
   e. Supplying the LFG to consumers through a dedicated pipeline;
4. Does not reduce the amount of organic waste that would be recycled in the absence of the project activity.

The methodology is only applicable if the most plausible baseline scenario is the atmospheric release of the LFG; capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odor concerns, or for other reasons; or gainful use of LFG at a lower rate than implemented in the project activity.

In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln:

1. For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or
2. For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.

In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.

In the case of LFG from a greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odor concerns, or for other reasons.

This methodology is not applicable:

1. In combination with other approved methodologies. For instance, this methodology cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;
2. If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.
3. If the emissions reductions associated with the project activity are claimed by more than one entity (e.g., the project proponent and a customer that purchases LFG for consumption offsite).

2.4 Geographic Scope

Global.

[3] For claiming emission reductions for other heat generation equipment, project proponents may submit a revision to this methodology for review.
[4] In case other means of transportation are used a revision to this methodology may be requested.

3. Materiality, Additionality, Permanence and Secondary Effects

3.1 Materiality

Materiality refers to information that, if omitted, erroneous or misstated, would lead to misrepresentation of radiative forcing (RF) reduction of a project. A materiality assessment is required for projects, with a materiality threshold of +/-5% of RF reductions in a given monitoring period. Materiality will be assessed by the validation and verification body (VVB) as part of validation and verification (see Section 7.5). See further discussion in Section 6.5 of the GHR Registry Standard.

In this category, errors, omissions, and misrepresentations that could significantly affect the estimation of the RF reduction potential associated with a project include, for example:

- Significant under-estimate or over-estimate of the methane emissions reduced by the project
- Misrepresentation of the project in terms of any eligibility or additionality requirements

3.2 Additionality Considerations

The project proponent must demonstrate additionality for projects that capture and destroy or use landfill gas, consistent with the GHR Registry Standard. In addition, the following conditions apply:

- The quantity of LFG to be captured and destroyed exceeds any amount of recovery which is required under national or local regulations; and
- Sales of generated LFG are insufficient to financially support the project development and activities.

The Project Proponent shall provide clear evidence for additionality in the Project Design Document (see Section 7.1).

3.3 Permanence

Once the landfill gas collection and destruction system is installed, it is likely to remain operational for the entire project period, as most of the costs of operation are up-front costs associated with installation, and LFG is a valuable product for use on-site/off-site. The annual methane emissions that would otherwise have been generated will be permanently reduced. Therefore, there is no risk of non-permanence of RF reductions achieved based on the emissions reductions achieved through this process.

The Project Proponent shall evaluate and report the risk of non-permanence at each monitoring period (see Section 7).

3.4 Risk of Secondary Effects

Secondary effects have the potential to increase greenhouse gas emissions or other contributors to positive RF associated with a project due to material substitutions or changes in activities or operations outside the project boundary. No secondary effects are considered for this project type.

4. Baseline and Project Scenario Descriptions

4.1 Baseline Scenario

The baseline scenario represents a business-as-usual situation, representing what would have occurred in the absence of the project activities. This methodology describes two potential baseline scenarios:

1. There is no LFG capture system within the project boundary, therefore any LFG generated by the landfill is vented to the atmosphere; or
2. There is an existing LFG capture system within the project boundary, but the LFG is either:
   a. Vented to the atmosphere; or
   b. Flared or gainfully used, but to a lesser extent than occurs due to the project activity. Note that all destruction of methane in the baseline scenario must be included in the baseline calculations.

The following applies if LFG is used in equipment that was in operation prior to the implementation of the project activity:

- For each item of equipment which was in operation prior to the implementation of the project activity and in which the captured LFG is used after the implementation of the project activity, project participants shall estimate its remaining lifetime by applying the CDM "*Tool to determine the remaining lifetime of equipment*"[5]. These items of equipment and their remaining lifetime shall be recorded in the Project Design Document (PDD).
- At the end of the remaining lifetime of each item of equipment, the procedure for the selection of the most plausible baseline scenario related to electricity and/or heat generation shall be updated in order to determine the most plausible baseline fuel that would be used after installation of the new equipment in the absence of the project activity. At the same time, the parameters related to this item of equipment shall also be re-estimated according to the procedures in this methodology used to make the original estimation (for example the baseline fuel may change, and this then has impacts on the emission factor for this baseline fuel).

4.2 Project Scenario

The project scenario is the installation or increase in capacity of a qualifying LFG collection and destruction or gainful use system.

4.3 Group Project Scenario

It is possible that multiple operations under one management and ownership system may apply for assessment and credit issuance in an aggregated group. All such operations within the group would be required to individually meet the requirements of the GHR Registry Standard and this methodology.

[5] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf/history_view

5. Project Boundaries

5.1 Boundaries for Assessing Radiative Forcing, Radiative Forcing Reduction, Co-benefits, and Trade-offs

The project boundary is the physical, geographical site where LFG is captured and, as applicable:

1. Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln, natural gas distribution network, dedicated pipeline or biogas processing facility);
2. Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity;
3. Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity in the baseline that is displaced by electricity generated by captured LFG in the project activity;
4. Heat generation equipment or sources which are supplying heat in the baseline that is displaced by heat generated by captured LFG in the project activity; and
5. The transportation of compressed/liquefied LFG from the biogas processing facility to consumers.

5.2 Sources, Sinks, and Reservoirs

NOTE: Delineate sources, sinks, and reservoirs to be analyzed for credits, as described in the GHR Registry Standard.

Project proponents shall account for all significant sources of climate forcer emissions and removals, both within and outside the project boundary (as described in Section 5.1), to provide an accurate estimation of the project's net impact on climate forcing. The exclusion of emission sources is permissible, provided the exclusions result in conservatively low crediting[6] and have been tested for their significance to total credit amounts. Sources (Table 1) that are considered significant and/or selected for accounting in the baseline scenario shall also be included in the project scenario.

Table 1. Climate forcer emission sources relevant to methane recovery projects

Source	Climate Forcer	Included in Calculation	Justification/Explanation
Uncontrolled anaerobic decay of landfill waste	CH_4	Required	Baseline methane emissions which are avoided under the project scenario.
Operation of LFG capture and destruction system	CO_2, CH_4, N_2O, NO_x, CO, Black Carbon, Organic Carbon, Sulfate aerosols	Required	Operating an LFG capture and destruction system requires powering pumps and other components. The use of grid electricity or burning of fuels (excluding LFG) to power these components results in climate forcer emissions.
LFG combustion	CO_2, CH_4, N_2O, NO_x, CO, Black Carbon, Organic	Required	LFG combustion produces CO_2 emissions

[6] .

	Carbon, Sulfate aerosols		
Flare emissions	CO_2, CH_4, N_2O, NO_x, CO, Black Carbon, Organic Carbon, Sulfate aerosols	Required	The efficiency of methane destruction via flaring is variable, therefore residual methane emissions are considered. Flaring has been shown to release other climate forcers which must be considered.
LFG distribution	CO_2, CH_4, N_2O, NO_x, CO, Black Carbon, Organic Carbon, Sulfate aerosols	Required	Emissions from trucks, dedicated pipelines, or other methods of distributing LFG (if applicable).

6. Quantification

6.1 Types of Data Required, Accepted Data Sources and Calculation Methods

Information about necessary data and parameters can be found in the calculations and descriptions in Sections 6.2 – 6.4, the tools utilized or mandated in this methodology, and in Section 7.2. A listing of the data and parameters available at validation, and monitored data and parameters is available in Appendix A.

6.2 Baseline Scenario Climate Forcer Calculation Methods

The project proponent shall calculate the baseline scenario climate forcer emissions using the following:

$$BE_{y,f} = BE_{CH4,y} + BE_{EC,y,f} + BE_{HG,y} + BE_{NG,y,f} + BE_{flare,y,f} \quad \textbf{Eq. 1}$$

Where:

$BE_{y,f}$	Baseline emissions in year *y*, for climate forcer *f* (tonnes)
$BE_{CH4,y}$	Baseline emissions of methane from the SWDS in year *y* (tonnes)
$BE_{EC,y,f}$	Baseline emissions associated with electricity generation in year *y*, for climate forcer *f* (tonnes)
$BE_{HG,y}$	Baseline emissions associated with heat generation in year *y* (tonnes). Calculated for CO_2 only.
$BE_{NG,y,f}$	Baseline emissions associated with natural gas use in year *y*, for climate forcer *f* (tonnes)
$BE_{flare,y,f}$	Baseline emissions associated with flaring in year *y*, for climate forcer *f* (tonnes)

Uncontrolled baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline. In addition, the effect of methane oxidation that is present in the baseline scenario and absent in the project scenario is taken into account:

$$BE_{CH4,y} = (1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH4,BL,y} \quad \textbf{Eq. 2}$$

Where:

$BE_{CH4,y}$	Baseline emissions of methane from the SWDS in year *y* (t CH_4)
OX_{top_layer}	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (unitless)
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4)
$F_{CH4,BL,y}$	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4)

During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + (F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}) \times Op_{j,h,y} \quad \textbf{Eq. 3}$$

Where:

$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4)
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4)
$F_{CH4,EL,y}$	Amount of methane in the LFG which is used for electricity generation in year *y* (t CH_4/h)
$F_{CH4,HG,y}$	Amount of methane in the LFG which is used for heat generation in year *y* (t CH_4/h)
$F_{CH4,NG,y}$	Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year *y* (t CH_4/h)
$Op_{j,h,y}$	Number of operating hours of equipment type *j* in year *y* (hours)

$F_{CH4,EL,y}$, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are determined using the CDM *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*[7] and monitoring the working hours of the power plant(s), boiler(s), air heater(s), glass melting furnace(s) and kiln(s), so that no emission reduction are claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{j,h,y}$).

For $F_{CH4,EL,y}$, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$, the following requirements apply:

- As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, paragraph 5 (a) and (b) of the Appendix of the CDM *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*[7] tool shall be followed;
- CH_4 is the greenhouse gas for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool);
- The mass flow should be calculated on an hourly basis for each hour h in year y;
- The mass flow calculated for hour h is 0 if the equipment is not working in hour h ($Op_{j,h,d}$ = not working), the hourly values are then summed to a yearly unit basis (Equation 4).

[7] Use latest version. Available at https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v1.pdf/history_view

$$Op_{j,h,y} = \sum_{d=1}^{365} Op_{j,h,d} \qquad \text{Eq. 4}$$

Where:

$Op_{j,h,y}$	Number of operating hours of equipment type *j* in year *y* (hours)
$Op_{j,h,d}$	Number of operating hours of equipment type *j* in day *d* of year *y* (hours)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - PE_{flare,y} \qquad \text{Eq. 5}$$

Where:

$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4)
$F_{CH4,sent\_flare,y}$	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4)
$PE_{flare,y}$	Methane emissions from incomplete combustion during flaring of the residual gas stream in year *y* (t CH_4)

$F_{CH4,sent\_flare,y}$ is determined directly using the CDM *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*[7], applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flare(s).

$PE_{flare,y}$ shall be determined using the CDM methodological tool *"Project emissions from flaring"*[8]. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

Non-methane baseline emissions from flaring are calculated as follows:

If CO_2: $BE_{flare,y,f} = BE_{flaring,y,CO2}$

If other forcer: $BE_{flare,y,f} = BE_{flaring,y,f}$ **Eq. 6**

Where:

$BE_{flare,y,f}$	Non-methane baseline emissions from flaring in year *y*, for climate forcer *f*
$BE_{flaring,y,CO2}$	CO_2 emissions from flaring in year *y* (t CO_2)
$BE_{flaring,y,f}$	Baseline emissions from flaring in year *y*, for climate forcer *f* (excluding CH_4 and CO_2)

[8] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf/history_view

Baseline CO_2 emissions from flaring shall be calculated using the following equation:

$$BE_{flaring,y,CO2} = F_{CO2,sent\_flare,y} + (F_{CH4,flared,y} \times MR_{CO2,CH4}) \quad \textbf{Eq. 7}$$

Where:

$BE_{flaring,y,CO2}$	CO_2 emissions from flaring in year y (t CO_2)
$F_{CO2,sent\_flare,y}$	Amount of CO_2 in the LFG which is sent to the flare in year *y* (t CO_2)
$F_{CH4,flared,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4)
$MR_{CO2,CH4}$	Mass ratio of CO_2 to CH_4 (2.744 t CO_2/t CH_4)

Other climate forcers emitted from baseline scenario flaring shall be calculated as follows:

$$BE_{flaring,y,f} = LFG_{sent\_flare,y} \times EF_{flaring,f} \quad \textbf{Eq. 8}$$

Where:

$BE_{flaring,y,f}$	Baseline emissions from flaring in year *y*, for climate forcer *f* (tonnes of *f*, excluding CH_4 or CO_2)
$LFG_{sent\_flare,y}$	Amount of LFG which is sent to the flare in year *y* (t LFG)
$EF_{flare,f}$	Emission factor for emissions from flaring, for climate forcer *f* (tonnes of *f*/t LFG)

An ex-ante estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS (according to Equation 2) in order to estimate the emission reductions of the proposed project activity in the PDD. This estimated $F_{CH4,PJ,y}$ value shall not be used for crediting purposes, See Equation 3 for ex-post calculation of $F_{CH4,PJ,y}$ to be used for crediting purposes. Ex-ante $F_{CH4,PJ,y}$ is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ,y} \times BE_{CH4,SWDS,y} \quad \textbf{Eq. 9}$$

Where:

$F_{CH4,PJ,y}$	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4)
$\eta_{PJ,y}$	Efficiency of the LFG capture system that will be installed in the project (unitless). To be estimated by the Project Proponent.
$BE_{CH4,SWDS,y}$	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CH_4)

$BE_{CH4,SWDS,y}$ is determined using the CDM methodological tool *"Emissions from solid waste disposal sites"*[9]. The following guidance should be taken into account when applying the tool:

a) f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in Equation (2) of this methodology;

[9] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v6.0.1.pdf/history_view

b) In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
c) Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

This section provides a procedure to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline.

If there is no existing LFG capture system, $F_{CH4,BL,y} = 0$.

If there is an existing LFG capture system, $F_{CH4,BL,y} = F_{CH4,BL,sys,y}$.

If the amount of methane captured with the existing system can be monitored separately from the amount captured under the project, and the efficiency of the existing system is not impacted on by the project system during the crediting period(s), then $F_{CH4,BL,sys,y}$ is determined as follows:

$$F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y} \quad \text{Eq. 10}$$

Where:

$F_{CH4,BL,sys,y}$	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (t CH_4)
$F_{CH4,sent\_flare,y}$	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4)

$F_{CH4,sent\_flare,y}$ is determined using the CDM *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*[7] and applying the requirements described in section 5.4.1.1 of the tool, where the gaseous stream the tool shall be applied to is the pipeline collecting LFG from the existing LFG capture system.

If there is no monitored data available, but there is historic data on the amount of methane that was captured in the year prior to the implementation of the project activity, then $F_{CH4,BL,sys,y} = F_{CH4,hist,y}$.

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} - F_{CH4,PJ,y} \quad \text{Eq. 11}$$

Where:

$F_{CH4,hist,y}$	Historical amount of methane in the LFG which is captured and destroyed in year *y* (t CH_4)
$F_{CH4,BL,x-1}$	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (t CH_4)
$F_{CH4,x-1}$	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (t CH_4)
$F_{CH4,PJ,y}$	Amount of methane in the LFG which is captured in the project activity in year *y* (t CH_4)

$F_{CH4,x-1}$ shall be estimated using the CDM methodological tool *"Emissions from solid waste disposal sites"*[9], applying the guidance and requirements described in section 5.4.1.2 of the tool. The year *y* in the tool is equivalent to the year prior to the implementation of the project activity.

If there is no monitored or historic data on the amount of methane that was captured in the year prior to the implementation of the project activities, then $F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y}$. This default value of 20 percent is based on assuming a situation in which: the efficiency of the LFG capture system in the project is 50 percent; the efficiency of the LFG capture system in the baseline is 20 percent; and the amount captured in the baseline is flared using an open flare with a destruction efficiency of 50 percent (consistent with the default value provided in the tool "*Project emissions from flaring*"[8]). Project participants may propose and justify an alternative default value as a request for revision to this methodology.

The baseline CO_2 emissions associated with electricity generation in year *y* ($BE_{EC,y}$) shall be calculated using the CDM *"Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"*[10]. When applying the tool:

- The electricity sources k in the tool correspond to the sources of electricity generated identified in the selection of the baseline scenario; and
- $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year y ($EG_{PJ,y}$).

Project emissions from the remaining climate forcers shall be calculated in a similar manner, using the baseline electricity and fuel use with the appropriate emission factor for each respective climate forcer.

[10] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf/history_view

The baseline emissions associated with heat generation in year y ($BE_{HG,y}$) are determined based on the amount of methane in the LFG which is sent to the heat generation equipment in the project activity (boiler, air heater, glass melting furnace(s) and/or kiln), as follows:

$$BE_{HG,y} = NCV_{CH4} \times \sum_{j=1}^{n} (R_{efficiency,j,y} \times F_{CH4,HG,dest,j,y} \times EF_{CO2,BL,HG,j}) \quad \text{Eq. 12}$$

Where:

$BE_{HG,y}$	Baseline emissions associated with heat generation in year *y* (t CO_2)
NCV_{CH4}	Net calorific value of methane at reference conditions (TJ/t CH_4)
$R_{efficiency,j,y}$	Ratio of the project and baseline efficiency of heat equipment type *j* in year *y* (unitless)
$F_{CH4,HG,dest,j,y}$	Amount of methane in the LFG which is destroyed for heat generation by equipment type *j* in year *y* (t CH_4)
$EF_{CO2,BL,HG,j}$	CO_2 emission factor of the fossil fuel type used for heat generation by equipment type *j* in the baseline (t CO_2/TJ)
j	Heat generation equipment (boiler, air heater, glass melting furnace(s) or kiln)
n	Number of different heat generation equipment used in the project activity

The ratio of the project and baseline efficiency of an air heater, boiler, glass melting furnace or kiln is determined as follows:

$$R_{efficiency,j,y} = min\{1; \frac{\eta_{HG,PJ,j,y}}{\eta_{HG,BL,j}}\} \quad \text{Eq. 13}$$

Where:

$R_{efficiency,j,y}$	Ratio of the project and baseline efficiency of heat equipment type *j* in year *y* (unitless)
$\eta_{HG,PJ,j,y}$	Efficiency of the heat generation equipment type *j* used in the project activity in year *y* (unitless)
$\eta_{HG,BL,j}$	Efficiency of the heat generation equipment type *j* used in the baseline (unitless)
j	Heat generation equipment (boiler, air heater, glass melting furnace(s) or kiln)

To estimate the baseline energy efficiency of an air heater, boiler, glass melting furnace(s) or kiln ($h_{HG,BL,j}$) project participants shall apply the CDM *"Tool to determine the baseline efficiency of thermal or electric energy generation systems"*[11].

[11] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v1.pdf/history_view

The amount of methane that is destroyed in the LFG that is sent to heat generation equipment *j* is determined with Equation 14 if *j* is a boiler, air heater, or glass melting furnace.

$$F_{CH4,HG,dest,j,y} = fd_{CH4,HG,j,default} \times F_{CH4,HG,j,y} \quad \text{Eq. 14}$$

Where:

$F_{CH4,HG,dest,j,y}$	Amount of methane in the LFG which is destroyed for heat generation by equipment type *j* in year *y* (t CH_4)
$fd_{CH4,HG,j,default}$	Default value for the fraction of methane destroyed when used for heat generation equipment type *j* (unitless)
$F_{CH4,HG,j,y}$	Amount of methane in the LFG which is used for heat generation equipment type *j* in year *y* (t CH_4)

$BE_{NG,y}$ is estimated as follows:

$$BE_{NG,y,f} = F_{CH4,NG,y} \times EF_{NG,f} \quad \text{Eq. 15}$$

Where:

$BE_{NG,y,f}$	Baseline emissions of climate forcer *f* associated with natural gas use in year *y* (t *f*)
$F_{CH4,NG,y}$	Amount of methane in the LFG which is sent to the natural gas distribution network or dedicated pipeline or to trucks in year *y* (t CH_4)
$EF_{NG,f}$	Emission factor of climate forcer *f* from use of natural gas in the natural gas network or dedicated pipeline or in the trucks in year *y* (t *f*/t CH_4)

6.3 Project Scenario Climate Forcer Calculation Methods

The project scenario climate forcer emissions shall be calculated as follows:

$$PE_{y,f} = PE_{LFG\_CO2} + PE_{EC,y,f} + PE_{FC,y,f} + PE_{flare,y,f} + PE_{DT,y,f} + PE_{SP,y,f} \quad \text{Eq. 16}$$

Where:

$PE_{y,f}$	Project emissions in year *y*, for climate forcer *f* (t *f*)
PE_{LFG_CO2}	Project CO_2 emissions from LFG destruction (excluding flares) in year *y. (t CO_2) Included only in calculation of CO_2 emissions, not for other climate forcers.*
$PE_{EC,y,f}$	Emissions from consumption of electricity due to the project activity in year *y*, for climate forcer *f* (t *f*)
$PE_{FC,y,f}$	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation in year *y*, for climate forcer *f* (t *f*)
$PE_{DT,y,f}$	Emissions from the distribution of compressed/liquefied LFG using trucks in the year *y*, for climate forcer *f* (t *f*)
$PE_{SP,y}$	Emissions from the supply of LFG to consumers through a dedicated pipeline in year *y* (t *f*)

It is presumed that LFG which is destroyed in a device other than a flare is completely converted to CO_2. While less potent of a climate forcer than methane, the radiative forcing of CO_2 emissions shall still be included in the emissions inventory. The project CO_2 emissions from the destruction of LFG in a device other than a flare shall be calculated as follows:

$$PE_{LFG\_CO2} = F_{CO2,sent\_dest,y} + (F_{CH4_{dest},y} \times MR_{CO2,CH4}) \quad \text{Eq. 17}$$

Where:

PE_{LFG_CO2}	Project CO_2 emissions from LFG destruction (excluding flares) in year *y (t CO_2)*
$F_{CO2,sent\_dest,y}$	Amount of CO_2 sent to a destruction device (excluding flares) in year *y (t CO_2)*
$F_{CH4_{dest},y}$	Amount of methane sent to a destruction device (excluding flares) in year *y* (t CH_4)
$MR_{CO2,CH4}$	Mass ratio of CO_2 to CH_4 (2.744 t CO_2/t CH_4)

The project CO_2 emissions from consumption of electricity by the project activity ($PE_{EC,y,CO2}$) shall be calculated using the CDM *"Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"*[10]. When applying the tool:

a) $EC_{PJ,k,y}$ in the tool is equivalent to the amount of electricity consumed by the project activity in year y ($EC_{PJ,y}$); and
b) If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y} > 0$), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the PDD.

Project emissions from the remaining climate forcers shall be calculated in a similar manner, using the project electricity use with the appropriate emission factor for each respective climate forcer.

The project CO_2 emissions from fossil fuel combustion for purposes other than electricity generation ($PE_{FC,y,CO2}$) shall be calculated using the CDM *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*[12]. When applying the tool:

a) Processes *j* in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars;
b) If in the baseline a proportion of LFG is captured and flared ($F_{CH4,BL,y} > 0$), then the fossil fuels consumption used in calculation ($FC_{i,j,y}$) should refer to the net of that consumed in the baseline. The determination of the amount of fossil fuels consumed in the baseline shall be transparently documented in the PDD.

Project emissions from the remaining climate forcers shall be calculated in a similar manner, using the project fuel use with the appropriate emission factor for each respective climate forcer.

The project emissions from flaring shall be calculated as the sum of the methane, CO_2, and other climate forcers released as a result of flaring LFG, as follows:

If CO_2: $$PE_{flare,y,f} = PE_{flaring,y,CO2}$$

If CH_4: $$PE_{flare,y,f} = PE_{flaring,y,CH4}$$ **Eq. 18**

If other forcer: $$PE_{flare,y,f} = PE_{flaring,y,f}$$

Where:

$PE_{flare,y,f}$	Project emissions from flaring in year *y*, for methane, CO_2, and climate forcer *f* *(tonnes)*
$PE_{flaring,y,CH4}$	Project CH_4 emissions from flaring in year *y* (t CH_4)
$PE_{flaring,y,CO2}$	Project CO_2 emissions from flaring in year *y* (t CO_2)
$PE_{flaring,y,f}$	Project emissions from flaring in year *y*, for climate forcer *f* (t *f*, excluding CH_4 or CO_2)

Methane emissions from flaring shall be calculated as follows:

$$PE_{flaring,y,CH4} = F_{CH4,sent\_flare,y} - F_{CH4,dest\_flare,y}$$ **Eq. 19**

Where:

$PE_{flaring,y,CH4}$	Project methane emissions from flaring of the residual gas stream in year *y* (t CH_4)
$F_{CH4,sent\_flare,y}$	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4)
$F_{CH4,dest\_flare,y}$	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4)

[12] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf/history_view

$F_{CH4,sent\_flare,y}$ is determined directly using the CDM *"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"*[7], applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flare(s).

$F_{CH4,dest\_flare,y}$ shall be determined using the CDM methodological tool *"Project emissions from flaring"*[8]. If LFG is flared through more than one flare, then $F_{CH4,dest\_flare,y}$ is the sum of the emissions for each flare determined separately.

Project CO_2 emissions from flaring shall be calculated using the following equation:

$$PE_{flaring,y,CO2} = F_{CO2,sent\_flare,y} + (F_{CH4,flared,y} \times MR_{CO2,CH4}) \quad \textbf{Eq. 20}$$

Where:

$PE_{flaring,y,CO2}$	Project CO_2 emissions from flaring in year *y* (t CO_2)
$F_{CO2,sent\_flare,y}$	Amount of CO_2 in the LFG which is sent to the flare in year *y* (t CO_2)
$F_{CH4,flared,y}$	Amount of project methane emissions in the LFG which is destroyed by flaring in year *y* (t CH_4)
$MR_{CO2,CH4}$	Mass ratio of CO_2 to CH_4 (2.744 t CO_2/t CH_4)

Other climate forcers emitted from flaring in the project scenario shall be calculated as follows:

$$PE_{flaring,y,f} = LFG_{sent\_flare,y} \times EF_{flaring,f} \quad \textbf{Eq. 21}$$

Where:

$PE_{flaring,y,f}$	Project emissions from flaring in year *y*, for climate forcer *f* (t *f*, excluding CH_4 or CO_2)
$LFG_{sent\_flare,y}$	Amount of LFG which is sent to the flare in year *y* (t LFG)
$EF_{flare,f}$	Emission factor for emissions from flaring, for climate forcer *f* (t *f*/t LFG)

The project emissions from the distribution of compressed/liquefied LFG using trucks ($PE_{DT,y,f}$) is determined by the sum of emissions arising from the transportation of LFG using trucks and possible leaks during the transportation, as follows:

$$PE_{DT,y,f} = PE_{TR,y,f} + PE_{leaks,y,f} \quad \textbf{Eq. 22}$$

Where:

$PE_{DT,y,f}$	Emissions from the distribution of compressed/liquefied LFG using trucks in the year *y*, for climate forcer *f* (t *f*)
$PE_{TR,y,f}$	Emissions from the transportation of compressed/liquefied LFG using trucks in year *y*, for climate forcer *f* (t *f*)
$PE_{leaks,y,f}$	Emissions from leaks during the transportation of compressed/liquefied LFG in year *y* (t *f*, *f* is limited to CO_2 and CH_4)

The project CO_2 emissions from the transportation of compressed/liquefied LFG using trucks ($PE_{TR,y,CO2}$) shall be accounted using the CDM methodological tool *"Project and leakage emissions from transportation of freight"*[13]. When applying the tool the following must be considered:

a) Transportation activity *f* in the tool corresponds to the distribution of compressing/liquefied LFG from the biogas processing plant to consumer(s) through using trucks;
b) The freight transported is the compressed/liquefied LFG.

Project emissions from the remaining climate forcers shall be calculated in a similar manner, using the project transportation fuel use with the appropriate emission factor for each respective climate forcer.

In addition to project emissions from transportation of freight, methane escape emissions from transport of the compressed/liquefied LFG by trucks shall also be computed as follows:

$$PE_{leaks,y} = F_{CH4,NG\,TR,y} - F_{CH4,NG-cons,y} \quad \textbf{Eq. 23}$$

Where:

$PE_{leaks,y}$	Emissions from methane escape during the transportation of compressed/liquefied LFG in year *y* (t CH_4)
$F_{CH4,NG\,TR,y}$	Amount of methane in the LFG which is sent to trucks in year *y* (t CH_4)
$F_{CH4,NG-cons,y}$	Amount of methane in the LFG which is delivered to consumers using trucks in year *y* (t CH_4)

The project emissions from the supply of LFG through a dedicated pipeline ($PE_{SP,y}$) shall be determined as follows:

$$PE_{SP,y} = EF_{SP} \times F_{CH4,NG,y} \quad \textbf{Eq. 24}$$

Where:

$PE_{SP,y}$	Emissions due to physical escape from the supply of LFG to consumers through a dedicated pipeline in year *y* (t CH_4)
$EF_{SP,y}$	Rate of physical escape of methane distributed through a dedicated pipeline[14] (unitless)
$F_{CH4,NG,y}$	Amount of methane in the LFG which is sent to the consumer through a dedicated pipeline in year *y* (t CH_4)

[13] Use latest version. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.pdf/history_view
[14] Project proponents may use the default leak rate of 10%, or another value based on on-site measurements or values found in literature, with justification.

6.4 Determination of the Project's Climate Impact

The project proponent shall determine the net climate forcer reductions as follows:

$$ER_{y,f} = BE_{y,f} - PE_{y,f} \quad \text{Eq. 25}$$

Where:

$ER_{y,f}$	Emission reductions in year *y*, for climate forcer *f* (t *f*)
$BE_{y,f}$	Baseline emissions in year *y*, for climate forcer *f* (t *f*)
$PE_{y,f}$	Project emissions in year *y*, for climate forcer *f* (t *f*)

Project participants should provide an ex-ante estimate of emissions reductions in the PDD. This requires projecting the future GHG emissions of the SWDS for the calculation of baseline emissions.

If the energy component is intended to be implemented after the first year of the project activity, then project participants may exclude the energy component from the ex-ante estimation of baseline emissions. This avoids overestimating ex ante estimate of emissions if energy generation is not implemented, or a lower capacity is implemented than originally envisaged. This exclusion is not applicable to the determination of the baseline or demonstration of additionality.

The potential credit amount in carbon dioxide equivalents (CO_2e) is calculated as shown in Equation 26:

$$R_{CO_2e,y} = ER_{y,CO_2} + \sum ER_{y,f} \times GWP_f \quad \text{Eq. 26}$$

Where:

$R_{CO_2e,t}$	Reduction in CO_2e due to project activities in year *y* (t CO_2e)
ER_{y,CO_2}	Net CO_2 emissions in year *y* (t CO_2)
$ER_{y,f}$	Net emissions in year *y* for climate forcer *f* (t *f*)
GWP_f	Global warming potential over 100 years (GWP 100) for climate forcer *f* (t CO_2e/t *f*, use IPCC values)[15]

The RF reduction (CO_2fe or W/m^2) in a given year is calculated as follows:

$$R_{CO_2fe,y} = \sum RF(ER_{y,f}) \quad \text{Eq. 27}$$

Where:

$R_{CO_2fe,y}$	Climate forcer reduction due to project activities in year y (t CO_2fe)
$ER_{y,f}$	Net emissions in year *y* for climate forcer *f* (tonnes)
$RF(ER_{y,f})$	RF of net climate forcer emissions in year *y. The function calculating RF for a given climate forcer (in CO_2fe, W/m^2, or derivative unit) is described in Appendix A of the Registry Standard.*

[15] See IPCC AR6 Table 7.SM.7 | Greenhouse gas lifetimes, radiative efficiencies, global warming potentials (GWPs), global temperature potentials (GTPs) and cumulative global temperature potentials (CGTPs). Available at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07_SM.pdf.

Additional details for calculating radiative forcing can be found in Appendix A of the Registry Standard. Radiative forcing shall also be calculated in W/m^2, or derivative unit (e.g., nanowatts per square meter, or nW/m^2) as described in the GHR Registry Standard. Accumulated RF reductions shall be calculated annually using the first year of the project as t_0.

6.5 Conservative Assumptions and Estimates

Several estimates are required to be included in the PDD before actual project measurements are available, using CDM estimation tools as directed in Sections 6.3 and 6.4. It is the responsibility of the project proponent to ensure these estimates are applied correctly and conservatively.

To identify the baseline fuel for electricity generation by captive fossil fuel fired power plants and/or heat generation:

a) Project participants shall demonstrate that the identified baseline fuel used for generation of electricity and/or heat is available in the host country and there is no supply constraint. In case of partial supply constraints (seasonal supply), the project participants shall consider the period of partial supply among potential alternative fuel(s) the one that results in the lowest baseline emissions;
b) Detailed justifications shall be provided and documented in the PDD for the selected baseline fuel. As a conservative approach, the lowest carbon intensive fuel, such as natural gas, may be used throughout all period of the year.

Emissions of methane from pipeline leaks are estimated to be 10% of the measured methane production unless a lower value can be justified based on project measurements or values found in literature.
The fraction of LFG which is not methane is assumed to be predominantly CO_2, and the fraction of other gases in LFG is assumed to be negligible.

6.6 Methods of Determining Uncertainty

Uncertainties may originate from estimated values and limitations in the accuracy of the systems used to measure the methane recovery and management processes. These uncertainties affect the baseline scenario, the measurement of methane recovery, the factors considered in the whole project emissions calculations, and the methane utilization or destruction processes. Each parameter used in the quantification (Sections 6.2 - 6.4) must have its uncertainty calculated from calibration checks, determined from relevant peer-reviewed scientific literature, or conservatively estimated with clear documentation, as applicable.

The degradation rate of methane in the atmosphere is well established in the literature and will be used for calculation purposes. Conservative assumptions listed in Section 6.5 may be used without uncertainty estimation requirements. Credit issuance will be discounted on a conservative basis reflecting on the variability in these parameters, as described in Section 8.

6.7 Potential Co-benefits, Trade-offs, and Sustainable Development Goals (SDGs)

The project proponent shall, at minimum, make a qualitative assessment of co-benefits and trade-offs associated with the project activities. The Project Proponent may self-report applicable SDGs using the

GHR SDG Contributions Reporting Tool. Self-reported SDGs must include justifications for each and will be made publicly available in the GHR Registry.

Alternatively, for verified claims, the latest Methodology Standard for Stressor-Effects Life Cycle Assessment (SCS-002) standard[13] may be used to make a quantitative assessment of any co-benefits and trade-offs. Verified claims related to co-benefits, trade-offs, and SDGs are only permissible when the project has undergone a quantitative assessment for the relevant impact category.

Table 2 shows a list of potential co-benefits and trade-offs relevant to this methodology. In the table, a "Yes" indicates that a co-benefit or trade-off may be applicable to the project, while a "No" indicates a lack of applicability.

Table 2. List of Impact Categories for determining Potential Co-benefits and Trade-offs

Impact Group	Impact Category	Potential Co-benefits relevant to Project Scenario	Potential Trade-off relevant to Project Scenario
Resource Depletion Group	Non-Renewable Energy Resource Depletion	Yes	No
	Net Freshwater Consumption	No	No
	Biotic Resource Depletion	No	No
Ocean Ecosystem Impacts Group	Ocean Acidification	No	No
	Marine Biome Disturbance	No	No
	Marine Eutrophication	No	No
	Key Species Loss	No	No
	Persistent Eco Toxic Chemical Loading	No	No
	Marine Plastic Loading	No	No
Terrestrial Ecosystem Impacts Group (impacts from Emissions)	Regional Acidification	No	No
	Stratospheric Ozone Depletion	No	No
	Freshwater Ecotoxic Exposure Risks	No	No
	Freshwater Eutrophication	No	No
	Terrestrial Eutrophication	No	No
Terrestrial Ecosystem Impacts Group (impacts from Land Use and Land Conversion)	Terrestrial Disturbance	No	No
	Freshwater Disturbance	No	No
	Threatened Species Impacts	No	No
Human Health Impacts (from Chronic Exposures to Hazardous Substances)	Ground Level Ozone Exposure Impacts	Project Dependent	
	PM2.5 Exposure Impacts	Project Dependent	
	Hazardous Ambient Air Contaminant Exposure Impacts	Yes	No
	Hazardous Indoor Air Contaminant Exposure Impacts	No	No
	Hazardous Food or Water Contaminant Exposure Impacts	No	No

Risks from Hazardous Wastes	Hazardous Dermal Contaminant Impacts	No	No
	Risks from Radioactive Wastes	No	No
	Risks from Untreated Hazardous Wastes	No	No

Projects which undergo a quantitative co-benefit and trade-off assessment may be eligible to make verified claims about the following SDGs and targets (determined using the GHR SDG Contributions Reporting Tool, pending assessment results:

Table 3. Potentially Verifiable SDGs and Targets

Sustainable Development Goal	Target Number	Target
3. Ensure healthy lives and promote well-being for all at all ages	3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
7. Ensure access to affordable, reliable, sustainable and modern energy for all	7.2	By 2030, increase substantially the share of renewable energy in the global energy mix
	7.b	By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support
11. Make cities and human settlements inclusive, safe, resilient and sustainable	11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
12. Ensure sustainable consumption and production patterns	12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production
13. Take urgent action to combat climate change and its impacts	13.2	Integrate climate change measures into national policies, strategies and planning

7. Reporting Requirements

7.1 Project Design Document (PDD)

A Project Design Document (PDD) is required to be developed by the Project Proponent under the Registry Standard at the outset of the project prior to validation and verification. It is subject to approval by GHR prior to registration in the GHR Registry.

The PDD will be published and publicly available in the GHR Registry. A Project Proponent may request redactions to some information in the PDD to protect intellectual property and other business confidential information (e.g., proof of eligibility information, the specific terms of legal agreements, and intellectual property detailed in life cycle assessments). Redaction will be at the sole choice of GHR but such permission will not be unreasonably withheld. However, all information will be subject to validation and verification requirements.

Specifications for the content of the Project Design Document can be found in the GHR Project Design Document Template.

7.2 Documentation and Monitoring

The project proponent must submit a detailed project monitoring plan as part of the Project Design Document (PDD). The monitoring plan should facilitate the gathering of all pertinent data needed for:

- Confirming the fulfilment of the eligibility requirements
- Confirming the emissions associated with the project and any emissions from secondary effects

The data gathered shall be kept on record for a minimum of five years following the conclusion of the project activity's final crediting period.

Details shall be provided and documented in the project monitoring plan to confirm that best practices are being utilized, as specified in the GHR Project Design Document. In cases where such methods and procedures are not known or accessible, the project will establish, document, and apply standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) processes for inventory tasks, including field data gathering and data management. It is advisable to use or modify SOPs obtained from published manuals.

The monitoring plan should include on-site inspections for each individual landfill included in the project boundary where the project activity is implemented for each verification period.

The following monitoring requirements from Climate Action Reserve's *U.S. Landfill Protocol* apply:

Methane emission reductions from landfill gas capture and control systems must be monitored with measurement equipment that directly meters:

- The flow of landfill gas delivered to each destruction device, measured continuously and recorded every 15 minutes or totalized and recorded at least daily, adjusted for temperature and pressure.
- The fraction of methane in the landfill gas delivered to the destruction device, measured continuously and recorded every 15 minutes and averaged at least daily (measurements taken at

a frequency that is less than continuous and more than weekly may be used with the application of a 10% discount in Equation 1). Projects may not be eligible for crediting if methane concentration is not measured and recorded at least weekly.

- The operational activity of the destruction device(s), monitored and documented at least hourly to ensure landfill gas destruction.

If discontinuous CH_4 concentration monitoring is to be employed, then the project proponent shall develop a prescriptive methodology for how such monitoring is to be carried out. The method should be reasonable in the circumstances of the project and shall be consistently applied throughout the reporting period. Any such methodology, and adherence to the methodology (or otherwise), should be clearly set out in the project monitoring plan.

Methane fraction of the landfill gas is to be measured on a wet/dry basis, depending on the basis of measurement for flow, temperature, and pressure (must be measured on same basis as flow, temperature, and pressure). The methane analyzer and flow meter should be installed in the same relative placement to any moisture-removing components of the landfill gas system (there should not be a moisture-removing component separating the measurement of flow and methane fraction). The meters themselves should also operate on the same basis (i.e., if one meter internally dries the sample prior to measurement, the same should occur at other meters). An acceptable variation to this arrangement would be in the case where flow is measured on a dry basis, while the methane concentration is measured on a wet basis. The opposite arrangement is not permissible. No separate monitoring of temperature and pressure is necessary when using flow meters that automatically correct for temperature and pressure, expressing LFG volumes in normalized cubic meters.

A single flow meter may be used for multiple destruction devices under certain conditions. If all destruction devices are of identical efficiency and verified to be operational, no additional steps are necessary for project registration. Otherwise, the destruction efficiency of the least efficient destruction device shall be used as the destruction efficiency for all destruction devices monitored by this meter.

If there are any periods when not all destruction devices measured under a single flow meter are operational, methane destruction during these periods will be eligible provided that the verifier can confirm all of the following conditions are met:

1. The destruction efficiency of the least efficient destruction device in operation shall be used as the destruction efficiency for all destruction devices monitored by this meter; and
2. All devices are either equipped with valves on the input gas line that close automatically if the device becomes non-operational (requiring no manual intervention), or designed in such a manner that it is physically impossible for gas to pass through while the device is non-operational; and
3. For any period where one or more destruction devices within this arrangement is not operational, it must be documented that the remaining operational devices have the capacity to destroy the maximum gas flow recorded during the period. For devices other than flares, it must be shown that the output corresponds to the flow of gas.

These means for allowing a single device to monitor operational activity at multiple destruction devices shall not be construed to relax the requirement for hourly operational data for all destruction devices. Rather, this arrangement permits a specific metering arrangement during periods when one or more devices are known to not be operating. In order to know the operational status of a device, it must be monitored. All destruction devices must have their operational status monitored and recorded at least hourly. In other words, the project dataset will include an indication of operational status corresponding to each hour of landfill gas data. If these data are missing or never recorded for a particular device, that device will be assumed to be not operating and no emission reductions may be claimed for landfill gas destroyed by that device during the period when data are missing.

All flow data collected must be corrected for temperature and pressure at 60 °F and 1 atm. If any of the landfill gas flow metering equipment does not internally correct for the temperature and pressure of the landfill gas, separate pressure and temperature measurements must be used to correct the flow measurement. The temperature and pressure of the landfill gas must be measured continuously. Corrected values must be used in all of the equations of this section. Apply Equation 5.2 in Climate Action Reserve's U.S. Landfill Project Protocol[Error! Bookmark not defined.] only if the landfill gas flow metering equipment does not internally correct for temperature and pressure.

The continuous methane analyzer should be the preferred option for monitoring methane concentrations, as the methane content of landfill gas captured can vary by more than 20% during a single day due to gas capture network conditions (dilution with air at wellheads, leaking pipes, etc.).[16] When using the alternative approach of discontinuous methane concentration measurement using a calibrated portable gas analyzer, project proponents must account for the uncertainty associated with these measurements by applying a 10% discount factor to the total quantity of methane collected and destroyed in Equation 1.

Figure 1 represents the suggested arrangement of the landfill gas flow meters and methane concentration metering equipment.

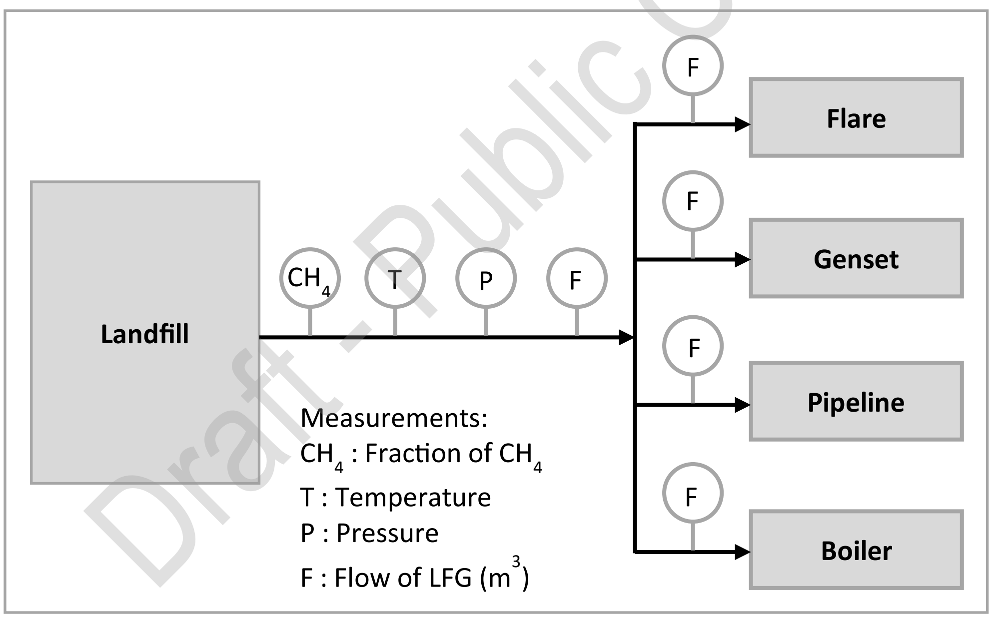

Figure 1: Suggested Arrangement of LFG Metering Equipment (recreated based on CAR U.S. Landfill Protocol)

Note: The number of flow meters must be sufficient to track the total flow as well as the flow to each combustion device. The above scenario includes one more flow meter than would be necessary to achieve

[16] Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

this objective. Source: Consolidated baseline methodology for landfill gas project activities, Clean Development Mechanism, Version 07, Sectoral Scope 13 (2007).

The operational activity of the landfill gas collection system and the destruction devices shall be monitored and documented at least hourly to ensure actual landfill gas destruction. GHG reductions will not be accounted for during periods that the destruction device was not operational. For flares, operation is defined as thermocouple readings above 500 °F. For all other destruction devices, the means of demonstration shall be determined by the project proponent and subject to verifier review. If relying on the difference between ambient temperatures and temperatures recorded by a thermocouple to demonstrate operational activity (instead of using a fixed temperature threshold), then a temperature difference of at least 200 °F shall be used. If any destruction device is equipped with a safety shut off valve, that prevents biogas flow to the destruction device when not operational, then demonstrating the presence and operability of the shut off valve will be sufficient to demonstrate operational activity of that device.

In "direct use" scenarios where landfill gas is delivered offsite to a third-party end user (not to a commercial natural gas transmission and distribution system or to a facility under management control of the project operator), reasonable efforts must be made to obtain data demonstrating the operational status of the destruction device(s). If it is not possible to obtain such data, the verifier must use their professional judgment to confirm that there has been no significant release of project landfill gas and that the project proponent is using the destruction efficiency value appropriate for the end use. Evidence that may assist a verifier in making a determination to that effect may include, but is not limited to, one or more of the following:

- A signed attestation from the third-party operator of the destruction device that no catastrophic failure of destruction or significant release of landfill gas occurred during the reporting period, and that the safety features and/or design of the destruction equipment are such that the destruction device does not allow landfill gas to pass through it when non-operational and/or that the project proponent is able to switch off the flow of landfill gas offsite in the event of emergencies (and has rigorous procedures in place to ensure such shutoff occurs immediately)
- The verifier confirming the same via a first-person interview with the third-party operator
- Examination of the safety features and/or design of the destruction equipment, such that the destruction device does not allow landfill gas to pass through it when non-operational and/or that the project proponent is able to switch off the flow of landfill gas offsite in the event of emergencies (and has rigorous procedures in place to ensure such shutoff occurs immediately)
- Records that can corroborate the type and level of operation of the destruction device during the reporting period, such as engine output data, etc. If the verifier is reasonably assured that no significant release of landfill gas has occurred offsite during the reporting period, the project can use the destruction efficiency appropriate to that offsite destruction device, despite the lack of hourly data from a monitoring device confirming operational status.

7.2.1 Indirect Monitoring Alternative

As an alternative to the direct measurement of LFG, projects may instead choose to demonstrate volumes of CH_4 destroyed using output data for their destruction device. Where the output of destruction devices (such as gensets) is measured via the use of a commercial transfer meter (i.e., a meter whose output is used as the basis for the quantification under an energy delivery contract), which is subject to regular, professional maintenance, the project may use such data as the basis for determining the volume of CH_4

destroyed. The meter output shall be subjected to an appropriate conversion methodology to calculate the volume of CH_4 destroyed during the reporting period. One example of a methodology that may be suitable is brake-specific fuel consumption calculations. Projects may also be able to use results of performance testing mandated under 40 CFR Part 60 Subpart IIII, Subpart JJJJ, and Subpart KKKK, to develop an appropriate conversion methodology. If using the indirect monitoring alternative, the commercial meter must be maintained by appropriately trained professionals, in accordance with manufacturer requirements. In scenarios where projects are able to control the maintenance of such meters, the QA/QC requirements in Section 6.2 of CAR's U.S. Landfill Protocol apply. In scenarios where projects are not able to control the maintenance of such meters, reasonable efforts must be made to obtain documentation demonstrating manufacturer maintenance requirements have been met during the reporting period.

The monitoring methodology to be employed must be clearly set out in the project monitoring plan, it must be applied consistently throughout the reporting period, and it must be demonstrated to the satisfaction of the project's verifier and the Reserve that the use of such data and methodology is reasonable under the circumstances, and results in a conservative estimation of the volume of CH4 destroyed.

7.2.2 Instrument QA/QC

Monitoring instruments shall be inspected and calibrated according to the following schedule. All gas flow meters[17] and continuous methane analyzers must be:

- Cleaned and inspected on a regular basis, as specified in the project's monitoring plan, with activities and results documented by site personnel. Cleaning and inspection procedures and frequency must, at a minimum, follow the manufacturer's recommendations
- Field checked for calibration accuracy by a third-party technician with the percent drift documented, using either a portable instrument (such as a pitot tube) or manufacturer specified guidance, at the end of – but no more than two months prior to or after – the end date of the reporting period.[18]
- Calibrated by the manufacturer or a certified third-party calibration service per manufacturer's guidance or every 5 years when calibration frequency is not specified by the manufacturer

Conformance with the factory calibration requirement is only required during periods of time where data gathered by the meter are used for emission reduction quantification. Periods where the meter did not meet this requirement will not cause the project to fail this requirement, provided the meter was not being used for project emission reduction quantification during such periods, and provided the meter was brought back into conformance before being employed to gather project data.

If a stationary meter that was in use for 60 days or more is removed and not reinstalled during a reporting period, that meter shall either be field-checked for calibration accuracy prior to removal or calibrated (with percent drift documented) by the manufacturer or a certified calibration service (with as-found results recorded) prior to quantification of emission reductions for that reporting period.

[17] Field checks and calibrations of flow meters shall ensure that the meter accurately reads volumetric flow and has not drifted outside of the prescribed +/-5% accuracy threshold.
[18] Instead of performing field checks, the project proponent may instead have equipment calibrated by the manufacturer or a certified calibration service per manufacturer's guidance, at the end of but no more than two months prior to or after the end date of the reporting period to meet this requirement.

If the required calibration or calibration check is not performed and properly documented, no GHG credits may be generated for that reporting period. Flow meter calibrations shall be documented to show that the meter was calibrated to a range of flow rates corresponding to the flow rates expected at the landfill. Methane analyzer calibrations shall be documented to show that the calibration was carried out to the range of conditions (temperature and pressure) corresponding to the range of conditions as measured at the landfill.

The as-found condition (percent drift) of a field check must always be recorded. If the meter is found to be measuring outside of the +/- 5% threshold for accuracy, the data must be adjusted for the period beginning with the last successful field check or calibration event up until the meter is confirmed to be in calibration (unless the last event occurred during the prior reporting period, in which case adjustment is made back to the beginning of the current reporting period). If, at the time of the failed field check, the meter is cleaned and checked again, with the as-left condition found to be within the accuracy threshold, a full calibration is not required for that piece of equipment. This shall be considered a failed field check, followed by a successful field check. The data adjustment shall be based on the percent drift recorded at the time of the failed field check. However, if the as-left condition remains outside of the +/- 5% accuracy threshold (whether additional cleaning and accuracy testing occurs), calibration is required by the manufacturer or a certified service provider for that piece of equipment.

For the interval between the last successful field check and any calibration event confirming accuracy outside of the +/- 5% threshold, all data from that meter or analyzer must be scaled according to the following procedure. These adjustments must be made for the entire period from the last successful field check until such time as the meter is properly calibrated.

1. For calibrations that indicate under-reporting (lower flow rates, or lower methane concentration), the metered values must be used without correction.
2. For calibrations that indicate over-reporting (higher flow rates, or higher methane concentration), the metered values must be adjusted based on the greatest calibration drift recorded at the time of calibration.

For example, if a project conducts field checks quarterly during a year-long reporting period, then only three months of data will be subject at any one time to the adjustments above. However, if the project proponent feels confident that the meter does not require field checks or calibration on a greater than annual frequency, then failed events will accordingly require the penalty to be applied to the entire year's data. Frequent calibration may minimize the total accrued drift (by zeroing out any error identified) and result in smaller overall deductions. Additionally, strong equipment inspection practices that include checking all probes and internal components will minimize the risk of meter and analyzer inaccuracies and the corresponding deductions. If it is not possible to determine the accrued drift and/or an appropriate method for scaling the data (e.g., drift is recorded in milliwatts, which cannot be directly translated into a drift percentage), the project proponent should seek guidance from the instrument manufacturer to confirm when the 5% drift threshold has been reached and how to appropriately scale the relevant data.

Additional field checks carried out during the reporting period at the project proponent's discretion may be performed by an individual that is not a third-party technician. In this case, the competency of the individual and the accuracy of the field check procedure must be assessed and approved by the verification body. Furthermore, if the field check reveals accuracy outside of the +/- 5% threshold, calibration is required, and the data must be scaled as detailed above. In order to provide flexibility in verification, data monitored up to two months after a field check may be verified. As such, the end date of the reporting period must be no more than two months after the latest successful field check.

If a portable instrument either:

1. acquires project data (e.g., a handheld methane analyzer is used to take weekly methane concentration measurements), or
2. is used to field check the calibration accuracy of equipment that acquires project data and the portable instrument produces a data output that is or could be used in emission reduction calculations (i.e., flow or concentration); then,

the portable instrument shall be maintained and calibrated per the manufacturer's specifications, and calibrated at least annually by the manufacturer, by a laboratory approved by the manufacturer, or at an ISO 17025 accredited laboratory. Other pieces of equipment used for QA/QC of monitoring instruments shall be maintained according to the manufacturer's specifications, including calibration where specified. Portable methane analyzers must also be field calibrated to a known sample gas prior to each use.

7.2.3 Missing Data

In situations where the flow rate or methane concentration monitoring equipment is missing data, the project proponent shall apply the data substitution methodology provided in Appendix D of Climate Action Reserve's U.S. Landfill Protocol. If for any reason the destruction device monitoring equipment is inoperable (for example, the thermocouple on the flare), then no emission reductions can be registered for the period of inoperability.

7.3 Monitoring Report

The Project Proponent shall generate a Monitoring Report to describe ongoing project activities addressed in the monitoring plan. Each Monitoring Report must cover the period from the last report to present, and will be published and publicly available in the GHR Registry.

Project Proponents may request redactions to some information in updated Monitoring Reports to protect intellectual property (IP). Redaction will be at the sole discretion of the GHR Registry, however, such permission will not be unreasonably withheld. All information will be subject to validation and verification requirements.

Content requirements for the Monitoring Reports are provided in the GHR Monitoring Report Template.

7.4 Monitoring Period

The monitoring period is the timespan over which the VVB assesses and confirms the Project's climate mitigation activities and resulting *ex-poste* GHG emission reductions/removals and other RF reductions per vintage year.

The monitoring period for projects assessed under this methodology shall be at most 5 years from the project start date or last date of verification.

During the monitoring period, the Project Proponent shall file an Incident Report if changes in processes, materials or activities are observed that could alter the level of RF reduction, describing the nature, timing, scale, and likely permanence of the change. An incident report must also be submitted to the Registry if actual RF reduction levels are shown to fall short of projections, whether due to a known loss event (i.e., a planned or unplanned change in process or activity) or due to any other cause describing the nature, extent, scope and expected permanence of the shortfall, and provide a root cause analysis of the source of the shortfall.

7.5 Project Validation and Verification

The Project shall be validated consistent with the requirements of Registry Standard Section 6.3.2.

The Project shall undergo verification within the monitoring period as defined above (Section 7.4).

Project validation and verification reports shall be provided to the GHR Registry by the VVB. Project validation and verification reports shall clearly describe the process of the assessment as well as the findings from the assessment. Specifications for the content of the validation and verification reports can be found in the GHR Validation and Verification Report Template.

8. Crediting

8.1 Credit Issuance

Credits will be issued after independent validation and verification that the requirements of this methodology have been met for methane recovery and management. Credit issuance will be adjusted to reflect inherent uncertainties in measuring and monitoring the project activities. The adjustment will be based on the uncertainty assessment conducted as part of the project's quantification process and reported in the Monitoring Reports. Credit issuance will be adjusted to reach a 90% or greater certainty in the quantified CO_2e.

Once issued, the credits will be registered and tracked in the GHR Registry. The registry will record the details of each credit, including the project it was issued for, the date it was issued, the retirement date and retirement location, the amount of net CO_2e it represents, and associated documentation. All GHR Registry credits may be retired for carbon accounting only once, and all retirements are recorded in the GHR Registry.

8.2 Crediting Period

The crediting period for projects under this methodology is 5 years. The project may be renewed up to two times and must be re-validated for each crediting period.

8.3 Buffer Pool Requirements

Methane capture and combustion projects are not reversible and therefore are subject to the GHR Registry Standard's lower minimum buffer pool contribution requirement of 2% of the total credits issued. However, this buffer pool contribution percentage is subject to review on a project-by-project basis, based on the parameters identified in Appendix B, and may be increased as warranted.

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Glossary

The definitions in this section apply to the terminology used in this methodology. A more comprehensive list of definitions can be found in the GHR Glossary of Terms.

Baseline Scenario: The business-as-usual scenario representing the project area environment and emissions in the absence of the project.

Landfill: A defined area of land or excavation that receives or has previously received waste that may include household waste, commercial solid waste, non-hazardous sludge and industrial solid waste.

Landfill gas: The gas generated by decomposition of waste in a SWDS. LFG is mainly composed of methane, carbon dioxide and small fractions of ammonia and hydrogen sulfide.

Landfill gas capture system: A system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Captured LFG can be vented, flared, or used.

Climate forcer: any external driver of climate change that causes a positive or negative change in RF (e.g., an emission, substance, process, activity or change in state). *Source: Radiative Forcing Protocol.*

Project area: The area within the project boundary where project activities take place. The project area may be contiguous or be comprised of multiple areas within a larger defined boundary.

Solid waste: Material that is unwanted and insoluble (including gases or liquids in cans or containers). Hazardous waste is not included in the definition of solid waste.

SWDS: see Landfill.

Acronyms and Abbreviations:
CDM: Clean Development Mechanism
GHG: Greenhouse gas
GWP: Global Warming Potential
IPCC: Intergovernmental Panel on Climate Change
LFG: Landfill gas
PDD: Project Design Document
RF: Radiative forcing
SOP: Standard Operating Procedure
SWDS: Solid waste disposal site
UNFCCC: United Nations Framework Convention on Climate Change

Appendix A: Data and Parameters

Data and Parameters Available at Validation

Data/Parameter:	OX_{top_layer}
Data Unit:	Unitless
Description:	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data:	Consistent with how oxidation is accounted for in the CDM methodological tool "Emissions from solid waste disposal sites"
Value to be applied:	0.1
Monitoring frequency:	--
QA/QC procedures:	--
Comments:	Applicable to Section 6.2 $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the CDM methodological tool "Emissions from solid waste disposal sites". In addition to this effect, the installation of an LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was very small, as the operators of the SWDS have in most cases an incentive to maintain a high methane concentration in the LFG. For these reasons, the oxidation factor shall be included in the calculation of baseline emissions whereas the effect of oxidation is, as a conservative assumption, neglected under the project activity

Data/Parameter:	$F_{CH4,BL,x-1}$
Data Unit:	t CH_4
Description:	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity
Source of data:	Information recorded by the SWDS operator
Value to be applied:	--
Monitoring frequency:	--
QA/QC procedures:	--
Comments:	Applicable to Section 6.2

Data/Parameter:	GWP_{CH4}

Data Unit:	t CO_2e/t CH_4
Description:	Global warming potential of CH_4
Source of data:	IPCC
Value to be applied:	Default value of 27.9 from IPCC Sixth Assessment (AR6). Shall be updated according to future reports.
Monitoring frequency:	--
QA/QC procedures:	--
Comments:	--

Data/Parameter:	NCV_{CH4}
Data Unit:	TJ/t CH_4
Description:	Net calorific value of methane at reference conditions
Source of data:	Technical literature
Value to be applied:	0.0504
Monitoring frequency:	--
QA/QC procedures:	--
Comments:	--

Data/Parameter:	$EF_{CO2,BL,HG,j}$
Data Unit:	t CO_2/TJ
Description:	CO_2 emission factor of the fossil fuel type used for heat generation by equipment type j in the baseline
Source of data:	Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value to be applied:	The lower limit of the 95 per cent confidence interval of the default values provided in table 1.4 of reference above shall be used
Monitoring frequency:	--
QA/QC procedures:	--
Comments:	Applicable to Section 6.2

<table>
<tr><td>Data/Parameter:</td><td>$fd_{CH4,HG,j,default}$</td></tr>
<tr><td>Data Unit:</td><td>Unitless</td></tr>
<tr><td>Description:</td><td>Default value for the fraction of methane destroyed when used for heat generation equipment type j</td></tr>
<tr><td>Source of data:</td><td>The values for boilers and air heaters are based on default values provided in the 2006 IPCC Guidelines (Tier 3 approach for Chapter 2: Stationary Combustion of Volume 2: Energy Use). The value for intermittent brick kilns is based on the assumption that combustion temperatures in the kiln will exceed 600 °C and that the time of exposure is sufficiently long to support 90 percent combustion</td></tr>
<tr><td>Value to be applied:</td><td>Select the appropriate factor for the fraction of methane destroyed from the following table:
<table>
<tr><td>Fraction of CH_4 destroyed</td><td>Equipment type j</td></tr>
<tr><td>1</td><td>Boilers</td></tr>
<tr><td>1</td><td>Air heaters</td></tr>
<tr><td>1</td><td>Glass melting furnaces</td></tr>
</table></td></tr>
</table>

	0.9	Intermittent brick kiln
Monitoring frequency:	--	
QA/QC procedures:	--	
Comments:	Applicable to calculating $F_{CH4,HG,dest,j,y}$ using Equation 14 in Section 6.2.	

Monitored Data and Parameters

Data/Parameter:	*Management of SWDS*
Data Unit:	--
Description:	Management of SWDS
Source of data:	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local or national regulations
Description of measurement methods and procedures to be applied:	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications
Frequency of monitoring/ recording:	Annually
QA/QC procedures to be applied:	--
Comments:	--

Data/Parameter:	$\eta_{HG,PJ,j,y}$
Data Unit:	Unitless
Description:	Efficiency of the heat generation equipment used in the project activity in year *y*
Source of data:	Use one of the following options to determine the efficiency: (a) Measured efficiency during monitoring; (b) Manufacturer's information on the efficiency; or (c) Use a default value of 60 percent
Description of measurement methods and procedures to be applied:	If measurements are conducted, use recognized standards for the measurement of the heat generator efficiency, such as the "British Standard Methods for Assessing the thermal performance of boilers for steam, hot water and high temperature heat transfer fluids" (BS845). Where possible, use preferably the direct method (dividing the net heat generation by the energy content of the fuels fired during a representative time period), as it is better able to reflect average efficiencies during a representative time period compared to the indirect method (determination of fuel supply or heat generation and estimation of the losses). Document measurement procedures and results and manufacturer's information transparently in the PDD

Frequency of monitoring/ recording:	Annually
QA/QC procedures to be applied:	--
Comments:	Applicable to Section 6.2

Data/Parameter:	$OP_{j,h,d}$
Data Unit:	Hours
Description:	Operation of the equipment that consumes the LFG
Source of data:	Project participants
Description of measurement methods and procedures to be applied:	For each equipment unit *j* using the LFG monitor that the plant is operating in hour *h* by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns. The equipment is not considered operational when: (a) One of more temperature measurements are missing or below the minimum threshold in hour *h* (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); (c) No products are generated in the hour *h*.
Frequency of monitoring/ recording:	Hourly
QA/QC procedures to be applied:	--
Comments:	Value is either 0 or 1 for each hour *h*, and between 0 and 24 for each day *d*

Data/Parameter:	$EG_{PJ,y}$
Data Unit:	MWh
Description:	Amount of electricity generated using LFG by the project activity in year *y*
Source of data:	Electricity meter
Description of measurement methods and procedures to be applied:	Monitor net electricity generation by the project activity using LFG
Frequency of monitoring/ recording:	Continuous

QA/QC procedures to be applied:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Comments:	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the CDM methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"

Data/Parameter:	$EG_{EC,y}$
Data Unit:	MWh
Description:	Amount of electricity consumed by the project activity in year *y*
Source of data:	Electricity meter
Description of measurement methods and procedures to be applied:	Sources of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications (boilers, power generators), for the compression of the LFG into the natural gas network, etc.
Frequency of monitoring/ recording:	Continuous
QA/QC procedures to be applied:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Comments:	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t $PE_{EC,y}$) using the CDM methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"

Data/Parameter:	$F_{CH4,NG\text{-}cons,y}$
Data Unit:	t CH_4
Description:	Amount of methane in the LFG which is delivered to consumers using trucks in year *y*
Source of data:	CDM tool calculation using records of LFG sale or transfer
Description of measurement methods and procedures to be applied:	Determined using the CDM "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Frequency of monitoring/ recording:	Per batch and aggregated annually
QA/QC procedures to be applied:	--
Comments:	--

Data/Parameter:	$F_{CH4,NG\ TR,y}$
Data Unit:	t CH_4
Description:	Amount of methane in the LFG which is sent to trucks in year *y*
Source of data:	CDM tool calculation using records of LFG sale or transfer

Description of measurement methods and procedures to be applied:	Determined using the CDM "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Frequency of monitoring/ recording:	Per batch and aggregated annually
QA/QC procedures to be applied:	--
Comments:	--

Data/Parameter:	$F_{CH4,NG,y}$
Data Unit:	t CH_4
Description:	Amount of methane in the LFG which is sent to the natural gas distribution network or dedicated pipeline or to trucks in year *y*
Source of data:	CDM tool calculation using records of LFG sale or transfer
Description of measurement methods and procedures to be applied:	Determined using the CDM "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Frequency of monitoring/ recording:	Continuous and aggregated annually in case of natural gas distribution network and dedicated pipeline. Pre-batch and aggregated annually in case of trucks
QA/QC procedures to be applied:	--
Comments:	--

Appendix B. Project Risks for Consideration When Establishing Buffer Pool Contributions

The following is a list of potential events that could affect the validity of credits issued for projects in any given specific project category. Methodologies representing specific project types provide additional guidance where applicable.

Reversal Risks

Environmental Events that result in the release of sequestered carbon, including:

- Fire
- Drought
- Disease/Pests
- Flood
- Earthquake
- Storms
- Heatwaves
- Avalanche

Human activity that unintentionally or deliberately result in the release of sequestered carbon

- Land-use changes (e.g., deforestation, urban development)
- Project site abandonment (due to inadequate management, financial failure, socio-political instability, economic crises, community opposition, etc.)
- Failure of maintenance or oversight

Regulatory, Legal, and Compliance Risks

Regulatory Changes

- Alterations in national or regional regulations that invalidate or require re-evaluation of credit validity.
- Introduction of new performance or safety standards that retroactively affect previously verified projects.

Legal Disputes

- Litigation challenging the validity of credits.
- Ownership disputes over land or resources related to the project.

Compliance Failures

- Failure to adhere to regulatory requirements after credit issuance.

- Non-compliance with ongoing monitoring and reporting obligations.

Project Implementation and Verification Risks

Inadequate technical capacity of the VVB, VVB contractor, or project proponent

- Deliberate or unintentional misrepresentation of project outcomes by the VVB, VVB contractor, or project proponents
- Inaccurate or incomplete Measurement, Reporting, and Verification processes leading to issuance of credits that do not reflect actual carbon reductions or removals
- Inaccurate data collection methods or issues related to the security, accuracy, and storage of data over time

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