ARTICLE 6.4 MECHANISM

A6.4-MEP009-A05

Draft Methodological tool

Mass flow of a greenhouse gas in a gaseous stream

Version 02.0

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Supervisory Body of the mechanism established by Article 6, paragraph 4, of the Paris Agreement (the Article 6.4 mechanism), at its fifteenth meeting,[1] approved its workplan for 2025 for the Methodological Expert Panel (MEP) and requested the MEP to initiate work on the revision of CDM methodologies, methodological tools, standards, and guidelines, including the CDM tool "TOOL08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (hereinafter referred to as the approved CDM Tool[2]).

2. The MEP, at its eight meeting, considered a draft version of the "Methodological tool: Determination of the mass flow of greenhouse gas in a gaseous stream"[3] and agreed to seek inputs from stakeholders. This draft version of the methodological tool was prepared by incorporating revisions to the approved CDM Tool to align with the requirements of Article 6.4 mechanism standards approved by the SBM for the development of new mechanism methodologies.

3. The public consultation was open from 9 September to 30 September 2025, and a total of 1 comment was received. A summary of the comment is provided in section 4 below.

2. Purpose

4. The purpose of this methodological tool is to provide the requirements, approaches and guidelines to determine mass flow of a greenhouse gas in a gaseous stream.

3. Key issues and proposed solutions

5. The methodological tool was developed based on the approved CDM Tool but was revised to align with the Article 6.4 mechanism framework and standards.

6. The methodological tool may be used to measure the mass flow of a greenhouse gases in gaseous streams under Article 6.4 baseline or project scenarios.

7. This methodological tool incorporates guidance from the Intergovernmental Panel on Climate Change (IPCC) on uncertainty analysis. Conservative adjustments (e.g., uncertainty factors) are applied to avoid underestimation or overestimation of the mass flow.

8. The table below provides a comparison of the key changes made to the approved CDM Tool.

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[1] See https://unfccc.int/sites/default/files/resource/A6.4-SBM015.pdf

[2] See https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf/history_view.

[3] See https://unfccc.int/sites/default/files/resource/A6.4-MEP008-A07.pdf.

Table Comparison of the main changes between the approved CDM Tool and the proposed methodological tool

Approved CDM Tool	Methodological tool
No uncertainty was considered in the default and monitored parameters	Guidance on determining and incorporating uncertainties were included

4. Consideration of public comments

9. One comment was received highlighting a typo in the molecular mass of N_2O in the “Data / Parameters table 2”, and the MEP corrected the value.

5. Impacts

10. The approval of this methodological tool will allow new Article 6.4 activities to determine the mass flow of a greenhouse gas in gaseous streams.

6. Subsequent work and timelines

11. This version of the methodological tool applies only to Article 6.4 projects and may be amended in the future to cover activities at other scales (e.g., programmes of activities, policies, sectoral approaches) once the adopted standards for the development of mechanism methodologies (e.g., additionality standard, baseline-setting standard) are revised to incorporate other scales.

7. Recommendations to the Supervisory Body

12. The MEP recommends the Supervisory Body to adopt this methodological tool.

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1. Introduction

1.1. Scope

1. This methodological tool establishes requirements, approaches and guidelines to determine the following parameter:

Table 1. Parameters determined

Parameter	SI Unit	Description
$F_{i,t}$	kg/h	Mass flow of greenhouse gas *i* (CO_2, CH_4, NF_3, N_2O, SF_6 or a PFC) in the gaseous stream in time interval *t*

2. The mass flow of a particular greenhouse gas is calculated based on measurements of: (a) the total volume flow or mass flow of the gas stream; (b) the volumetric fraction of the gas in the gas stream; and (c) the gas composition and water content. The flow and volumetric fraction may be measured on a dry basis or wet basis. This methodological tool covers the possible measurement combinations, providing six different calculation options to determine the mass flow of a particular greenhouse gas and the uncertainty associated with the measurement (Options A to F shown in Table 1).

3. Additional guidance for determining the mass flow of methane in biogas is provided in the Appendix to this methodological tool.

1.2. Entry into force and validity

4. This methodological tool enters into force on DD/MM/YYYY.

5. This methodological tool remains valid for five years, until DD//MM/YYYY, unless an earlier date applies if this methodological tool is revised or withdrawn in accordance with the “Procedure: Development, revision and clarification of methodologies and methodological tools” (A6.4-PROC-METH-001).[1]

2. Definitions

2.1. General terms

6. The following general terms are applied to this methodological tool:

(a) "Shall" is used to indicate requirements that must be followed;

(b) "Should" is used to indicate that, among several options, one course of action is recommended as particularly suitable;

(c) "May" is used to indicate what is permitted.

[1] See https://unfccc.int/sites/default/files/resource/A6.4-PROC-METH-001.pdf

2.2. Methodological terms and definitions

7. The following methodological tool terms and definitions are applied to this methodological tool:

(a) **Activity participant:** A public or private entity that participates in an Article 6.4 activity;

(b) **Absolute humidity:** The ratio between the mass of H_2O (vapour phase) in the gas and the mass of the dry gas;

(c) **Dry basis:** A parameter that does not account for the H_2O present in the gas;

(d) **Gaseous stream:** A mixture of gaseous components that may contain different fractions of N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6, PFCs and H_2O in the vapour phase, with an absolute pressure below 10 atm or 1.013 MPa.[2] Other gases may be present (e.g. hydrocarbons), provided their total concentration represents less than 1 per cent (v/v) of the total.[3] A dry gas or dry gaseous stream excludes the H_2O fraction, and a wet gas or wet gaseous stream includes the H_2O fraction;

(e) **Moisture content:** The H_2O concentration, expressed as the mass of H_2O (vapour phase) per volume of dry gas at normal conditions (also referred to as NPT conditions), in mg H_2O/m^3 dry gas;

(f) **Reference conditions:** Conditions defined as 0ºC (273.15 K, 32ºF) and 1 atm (101.325 kN/m2, 101.325 kPa, 14.69 psia, 29.92 in Hg, 760 torr);

(g) **Relative humidity:** The ratio between the partial pressure of H_2O in the gas and the saturation pressure at a given temperature;

(h) **Saturation (absolute) humidity:** The maximum amount of H_2O (vapour phase) that the gas can contain at a given temperature and pressure, expressed as the mass of H_2O per mass of the dry gas;

(i) **Wet basis:** A parameter that accounts for the H_2O present in the gas.

8. Further definitions from the "Article 6.4 Glossary of Terms", once adopted by the Supervisory Body, shall also apply to this methodological tool.

3. Applicability

9. Mechanism methodologies intending to use this methodological tool shall include a reference to this tool within the mechanism methodology and shall specify to which gaseous stream and which greenhouse gases in the gaseous streams it shall be applied.

[2] This condition is required because it is assumed in the calculations that the gas stream behaves as an ideal binary mixture of water vapour and an ideal gas. If the gaseous stream contains larger fractions of other gases, such as hydrocarbons other than methane or HFCs, the gas cannot be considered an ideal gas mixture. Moderate pressures will ensure that gases behave as ideal gases.

[3] For the cases of landfill gas and exhaust gases from thermal oxidation using natural gas, it will [shall] be assumed that the total concentration of other gases represents less than 1per cent (v/v).

10. This methodological tool is used to measure the mass flow of greenhouse gases in gaseous streams under Article 6.4 baseline or project scenarios and may be used by mechanism methodologies related to emission reductions and/or net removals.

11. This version of the methodological tool applies only to Article 6.4 projects and may be amended in the future to cover activities at other scales (e.g., programmes of activities, policies, sectoral approaches) once the adopted standards for the development of mechanism methodologies (e.g., additionality standard, baseline-setting standard) are revised to incorporate other scales.

12. This methodological tool applies to ideal gases only and shall be updated in the future to incorporate CO_2 under non-ideal gases condition (e.g., for geological storage).

13. Mechanism methodologies intending to use this methodological tool shall include a reference to it and shall specify:

    (a) The gaseous streams to which the methodological tool shall be applied to;

    (b) The greenhouse gas for which the mass flow shall be determined;

    (c) The time intervals at which the flow of the gaseous stream shall be measured; and

    (d) Situations where the simplification offered for calculating the molecular mass of the gaseous stream (Equations (3) or (17)) is not valid (e.g., where the gaseous stream is predominantly composed of a gas other than N_2).

14. The provisions in paragraph 13 above shall be demonstrated in the Project Design Document (PDD) and in each monitoring report and be assessed at the validation and at each verification.

15. Mechanism methodologies may specify additional provisions for the application of this tool in relation to the mitigation activity types they cover. Where the mechanism methodology referring to this tool specifies approaches that differ from those described in this tool, the requirements contained in the mechanism methodology shall take precedence.

4. Normative and informative references

16. The following normative document is indispensable for the application of this methodological tool. The most recent version of the documents listed shall apply:

    (a) “Methodological tool: Project emissions form flaring” (hereinafter referred to as “flaring tool”)[4]

17. The following informative documents provide supporting information that may assist in the application of this methodological tool

    (a) G. J. Van Wylen, R. E. Sonntag, and C. Borgnakke, *Fundamentals of Classical Thermodynamics*, 4th ed. New York: John Wiley & Sons, 1994;

    (b) C. Strumillo and T. Kudra, *Drying: Principles, Applications and Design*. Montreux, Switzerland: Gordon & Breach Science Publishers, 1986;

[4] Currently published together with this methodological tool. However, once the tool is approved by the Supervisory Body the workbook will be published separately.

(c) IPCC, *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 1: General guidance and reporting.* Chapter 3: Uncertainties.[5]

5. Methodological approaches

18. The mass flow of a greenhouse gas *i* in a gaseous stream ($F_{i,t}$) is determined through measurement of the flow of the gaseous stream and the volumetric fraction of the relevant greenhouse gas within the gaseous stream. This methodological tool offers different options to conduct these measurements and the corresponding calculation option to determine $F_{i,t}$, as shown in Table 1.

19. Activity participants shall document in the PDD which option is applied. $F_{i,t}$ shall be calculated following the steps described for each option below.

Table 1. Measurement options

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow – dry basis	Dry or wet basis[6]
B	Volume flow – wet basis	Dry basis
C	Volume flow – wet basis	Wet basis
D	Mass flow – dry basis	Dry or wet basis
E	Mass flow – wet basis	Dry basis
F	Mass flow – wet basis	Wet basis

20. Section 5.1 contains guidance on how to determine the absolute humidity in a gaseous stream and Section 5.2 contains requirements and equations to determine $F_{i,t}$ for each of the options above.

21. Activity participants may use the “Workbook: Mass flow of a GHG in a Gaseous Stream”, made available on the UNFCCC website,[7] to calculate the flow of gaseous streams. The workbook is provided as a supporting resource to assist in the calculation, but its use is not mandatory.

5.1. Determination of the absolute humidity of the gaseous stream

22. The absolute humidity is a parameter required for Options B and E. It may be determined from the measurement of the moisture content (Option 1) or, as a simplified conservative approach, by assuming that the gaseous stream is dry or saturated (Option *2*). Activity participants shall document in the PDD which option they apply.

[5] See https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch03_Uncertainties.pdf.

[6] Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analyzers and dry basis analyzers and both types can be used indistinctly for calculation Options A and D.

[7] Currently published together with this methodological tool. However, once the tool is approved by the Supervisory Body the workbook will be published separately.

5.1.1. Option 1: Calculation using measurement of the moisture content

23. This option provides the approach to determine the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) from measurements of the moisture content of the gas, in accordance with Equation (1).

$$m_{H2O,t,db} = \frac{C_{H2O,t,db,n}}{10^6 \times \rho_{t,db,n}}$$ Equation (1)

Where:

$m_{H2O,t,db}$	=	Absolute humidity of the gaseous stream in time interval *t* on a dry basis ($kg_{H2O}/kg_{dry\ gas}$)
$C_{H2O,t,db,n}$	=	Moisture content of the gaseous stream in time interval *t* on a dry basis at normal conditions ($mg_{H2O}/m^3_{dry\ gas}$)
$\rho_{t,db,n}$	=	Density of the gaseous stream in time interval *t* on a dry basis at normal conditions ($kg_{dry\ gas}/m^3_{dry\ gas}$)

24. The density of the gaseous stream on a dry basis at normal conditions ($\rho_{t,db,n}$) shall be determined as follows:

$$\rho_{t,db.n} = \frac{P_n \times MM_{t,db}}{R_u \times T_n}$$ Equation (2)

Where:

$\rho_{t,db.n}$	=	Density of the gaseous stream in time interval *t* on a dry basis at normal conditions ($kg_{dry\ gas}/m^3_{dry\ gas}$)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval *t* on a dry basis ($kg_{\ dry\ gas}/kmol_{\ dry\ ga}$s)
R_u	=	Universal ideal gases constant ($Pa.m^3/kmol.K$)

25. The molecular mass of the gaseous stream ($MM_{t,db}$) shall be estimated as follows:

$$MM_{t,db} = \sum_k \left(v_{k,t,db} \times MM_K\right)$$ Equation (3)

Where:

$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_K	=	Molecular mass of gas *k* (kg/kmol)
k	=	All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs). See available simplification below

26. The determination of the $MM_{t,db}$ requires the measurement of the volumetric fraction of all gases (k) in the gaseous stream. However, as a simplification, only the volumetric fraction of the gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying mechanism methodology maybe monitored, and the difference to 100 per cent may be considered as pure nitrogen. This simplification shall not be applied if the underlying mechanism methodology specifies otherwise.

5.1.2. Option 2: Simplified calculation without measurement of the moisture content

27. This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is either dry or saturated, depending on which assumption is the more conservative.[8]

28. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ shall be assumed to equal 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ shall be assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$), calculated using Equation (4).

$$m_{H2O,t,db,Sat} = \frac{p_{H20,t,Sat} \times MM_{H2O}}{\left(P_t - p_{H20,t,Sat}\right) \times MM_{t,db}}$$ Equation (4)

Where:

$m_{H2O,t,db,Sat}$	=	Saturation absolute humidity in time interval t on a dry basis ($kg_{H2O}/kg_{dry\ gas}$)
$p_{H20,t,Sat}$	=	Saturation pressure of H_2O at temperature T_t in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval t (K)
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_{H2O}	=	Molecular mass of H_2O ($kg_{H2O}/kmol_{H2O}$)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval t on a dry basis ($kg_{dry\ gas}/kmol_{dry\ gas}$)

29. Parameter $MM_{t,db}$ is estimated using Equation (3).

5.2. Determination of the mass flow for the different measurement options

5.2.1. Option A

30. Flow measurement on a dry basis is not feasible for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

(a) Measure the moisture content of the gaseous stream ($c_{H2O,t,db,n}$) and demonstrate that it is less or equal to 0.05 $kg_{H2O}/m^3_{dry\ gas}$; or

[8] An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas i is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas i is overestimated (applicable for calculating project emissions).

(b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

31. If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement shall be assumed to be on a wet basis and the corresponding option from Table 1 shall be applied instead.

32. The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ Equation (5)

With:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$ Equation (6)

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg_{gas}/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis ($m^3_{dry\ gas}/h$)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis ($m^3_{gas\ i}$ / $m^3_{dry\ gas}$)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream in time interval *t* ($kg_{gas\ i}$ / $m^3_{gas\ i}$)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m³/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

5.2.2. Option B

33. The mass flow of greenhouse gas *i* ($F_{i,t}$) shall be determined using Equations (5) and (6). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) shall be determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = {V_{t,wb}}/{(1 + v_{H2O,t,db})}$$ Equation (7)

Where:

$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis ($m^3_{dry\ gas}/h$)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis ($m^3_{wet\ gas}/h$)
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis ($m^3_{H2O}/m^3_{dry\ gas}$)

34. The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to Equation (8).

$$v_{H20,t,db} = \frac{m_{H2O,t,db} \times MM_{t,db}}{MM_{H2O}}$$ Equation (8)

Where:

$v_{H20,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis ($m^3_{H2O}/m^3_{dry\ gas}$)
$m_{H2O,t,db}$	=	Absolute humidity in the gaseous stream in time interval *t* on a dry basis ($kg_{H2O}/kg_{dry\ gas}$)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis ($kg_{\ dry\ gas}/kmol_{\ dry\ gas}$)
MM_{H2O}	=	Molecular mass of H_2O ($kg_{H2O}/kmol_{H2O}$)

35. The absolute humidity of the gaseous stream ($m_{H2O,t,db}$) shall be determined using either Option 1 or Option 2 specified in Section 5.1, Determination of the absolute humidity of the gaseous stream, and the molecular mass of the gaseous stream ($MM_{t,db}$) shall be determined using Equation (3).

5.2.3. Option C

36. The mass flow of greenhouse gas *i* ($F_{i,t}$) shall be determined as follows:

$$F_{i,t} = V_{t,wb,n} \times v_{i,t,wb} \times \rho_{i,n}$$ Equation (9)

With

$$\rho_{i,n} = \frac{P_n \times MM_i}{R_u \times T_n}$$ Equation (10)

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,wb,n}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis at normal conditions ($m^3_{wet\ gas}/h$)
$v_{i,t,wb}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a wet basis ($m^3_{gas\ i}$ / $m^3_{wet\ gas\ i}$)
$\rho_{i,n}$	=	Density of greenhouse gas *i* in the gaseous stream at normal conditions ($kg_{gas\ i}$ / $m^3_{wet\ gas\ i}$)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant ($Pa.m^3/kmol.K$)

37. The following equation shall be used to convert the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n} = V_{t,wb} \times \left(\frac{T_n}{T_t}\right) \times \left(\frac{P_t}{P_n}\right)$$ Equation (11)

Where:

$V_{t,wb,n}$	=	Volumetric flow of the gaseous stream in a time interval *t* on a wet basis at normal conditions (m^3 wet gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis ($m^3_{wet\ gas}$/h)
P_t	=	Pressure of the gaseous stream in time interval *t* (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)

5.2.4. Option D

38. Flow measurement on a dry basis is not feasible for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

(a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that it is less than or equal to 0.05 kg H_2O/m^3 dry gas; or

(b) Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

39. If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement shall be assumed to be on a wet basis and the corresponding option from Table 1 shall be applied instead.

40. The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using Equations (5) and (6). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) shall be determined by converting the mass flow of the gaseous stream to a volumetric flow as follows:

$$V_{t,db} = \frac{M_{t,db}}{\rho_{t,db}}$$ Equation (12)

Where:

$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$M_{t,db}$	=	Mass flow of the gaseous stream in time interval *t* on a dry basis (kg/h)
$\rho_{t,db}$	=	Density of the gaseous stream in time interval *t* on a dry basis (kg dry gas/m^3 dry gas)

41. The density of the gaseous stream ($\rho_{t,db}$) shall be determined as follows:

$$\rho_{t,db} = \frac{P_t \times MM_{t,db}}{R_u \times T_t}$$ Equation (13)

Where:

$\rho_{t,db}$	=	Density of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/m^3 dry gas)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)
P_t	=	Pressure of the gaseous stream in time interval *t* (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

42. The molecular mass of the gaseous stream ($MM_{t,db}$) shall be estimated using Equation (3).

5.2.5. Option E

43. The mass flow of greenhouse gas *i* ($F_{i,t}$) shall be determined using Equations (5) and (6). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) shall be determined in two steps. First, the mass flow of the gaseous stream in time interval *t* on a wet basis ($M_{t,wb}$) shall be converted from wet basis to dry basis as follows:

$$M_{t,db} = \frac{M_{t,wb}}{\left(1 + m_{H2O,t,db}\right)}$$ Equation (14)

Where:

$M_{t,db}$	=	Mass flow of the gaseous stream in time interval *t* on a dry basis (kg/h)
$M_{t,wb}$	=	Mass flow of the gaseous stream in time interval *t* on a wet basis (kg/h)
$m_{H2O,t,db}$	=	Absolute humidity of H_2O in the gaseous stream in a time interval *t* on a dry basis (kg $_{H2O}$/kg $_{dry\ gas}$)

44. Then, the mass flow of the gaseous stream in time interval *t* on a dry basis ($M_{t,db}$) shall be converted to the volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) using Equation (12).

45. The absolute humidity of the gaseous stream ($m_{H2O,t,db}$) shall be determined using either Option 1 or Option 2 specified in Section 5.1, “Determination of the absolute humidity of the gaseous stream”.

5.2.6. Option F

46. The mass flow of greenhouse gas *i* ($F_{i,t}$) shall be determined using Equations (9), (10), and the following equations:

$$V_{t,wb,n} = \frac{M_{t,wb}}{\rho_{t,wb,n}}$$ Equation (15)

And

$$\rho_{t,wb,n} = \frac{P_n \times MM_{t,wb}}{R_u \times T_n} \quad \text{Equation (16)}$$

Where:

$V_{t,wb,n}$	=	Volumetric flow of the gaseous stream in time interval *t* at normal conditions on a wet basis ($m^3_{wet\ gas}/h$)
$V_{i,t,wb}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a wet basis ($m^3_{gas\ i}$ / $m^3_{wet\ gas}$)
$M_{t,wb}$	=	Mass flow of the gaseous stream in time interval *t* on a wet basis (kg/h)
$\rho_{t,wb,n}$	=	Density of the gaseous stream in time interval *t* on a wet basis at normal conditions ($kg_{wet\ gas}/m^3_{wet\ gas}$)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)
$MM_{t,wb}$	=	Molecular mass of the gaseous stream in time interval *t* on a wet basis ($kg_{wet\ gas}/kmol_{wet\ gas}$)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)

47. The molecular mass of the gaseous stream ($MM_{t,wb}$) shall be determined as follows:

$$MM_{t,wb} = \sum_k \left(v_{k,t,wb} \times MM_k\right) \quad \text{Equation (17)}$$

Where:

$MM_{t,wb}$	=	Molecular mass of the gaseous stream in time interval *t* on a wet basis ($kg_{wet\ gas}/kmol_{wet\ gas}$)
$v_{k,t,wb}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a wet basis ($m^3_{gas\ k}$ / $m^3_{wet\ gas}$)
MM_k	=	Molecular mass of gas k (kg/kmol)
k	=	All gases contained in the gaseous stream (e.g. N_2, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs and H_2O in vapor phase). See available simplification below

48. The determination of the molecular mass of the gaseous stream ($MM_{t,wb}$) requires the measurement of the volumetric fraction of all gases (*k*) in the gaseous stream. However, as a simplification, only the volumetric fraction of the gases *k* that are greenhouse gases and are considered in the emission reduction calculation in the underlying mechanism methodology shall be monitored, and the difference to 100 per cent may be considered as pure nitrogen. This simplification shall not be applied if the underlying mechanism methodology specifies otherwise.

5.3. Uncertainty determination

49. The uncertainty shall be determined by considering the uncertainty in data and measurements of all required parameters, following the guidance in "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories," Volume 1: General

guidance and reporting, Chapter 3: Uncertainties. The uncertainty shall be expressed as the standard error of the mean and incorporated into the uncertainty calculations in the mechanism methodology.

5.4. Data and parameters not monitored

Data / Parameter table 1.

Data/parameter	$\boldsymbol{R_u}$
Description	Universal ideal gases constant
Data unit	Pa.m³/kmol.K
Equations referred	(2), (6), (10), (13), (16)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	8,314
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Universal constant
Treatment of uncertainties	N/A
Additional comments	-

Data / Parameter table 2.

Data/parameter	$\boldsymbol{MM_i}$
Description	Molecular mass of greenhouse gas *i*
Data unit	kg/kmol
Equations referred	(6), (10)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	(see table below)

Compound	Structure	Molecular mass (kg / kmol)	Uncertainty (%)
Carbon dioxide	CO_2	44.009	$\pm$ 0.0064
Methane	CH_4	16.043	$\pm$ 0.013
Nitrogen trifluoride	NF_3	71.001	$\pm$ 0.0045
Nitrous oxide	N_2O	44.013	$\pm$ 0.0051
Perfluoromethane	CF_4	88.003	$\pm$ 0.0051
Perfluoroethane	C_2F_6	138.01	$\pm$ 0.0052
Perfluoropropane	C_3F_8	188.017	$\pm$ 0.0053
Perfluorobutane	C_4F_{10}	238.024	$\pm$ 0.0054
Perfluorocyclobutane	c-C_4F_8	200.028	$\pm$ 0.0057
Perfluoropentane	C_5F_{12}	288.031	$\pm$ 0.0054
Perfluorohexane	C_6F_{14}	338.038	$\pm$ 0.0055
Sulfur hexafluoride	SF_6	146.048	$\pm$ 0.014

Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	The molecular mass and the uncertainty of the elements C, H, O, N, F, and S were sourced from the periodic table of elements published by the International Union of Pure and Applied Chemistry (IUPAC).[9] The molar mass of the substances was determined by multiplying the molecular mass of each atom by the number of atoms in each substance, and the uncertainty was calculated using the error propagation method, based on the uncertainty of the molecular mass of each substance
Treatment of uncertainties	Refer to Table 1 above, in row "Values applied"
Additional comments	-

Data / Parameter table 3.

Data/parameter	MM_k
Description	Molecular mass of gas *k*
Data unit	kg/kmol
Equations referred	(3), (17)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	See table below
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	The molecular mass and the uncertainty of the elements C, H, O, N, and S were sourced from the periodic table of elements published by the International Union of Pure and Applied Chemistry (IUPAC). The molecular mass of the substances was determined by multiplying the molecular mass of each atom by the number of atoms in each substance, and the uncertainty was calculated using the error propagation method, based on the uncertainty of the molecular mass of each substance
Treatment of uncertainties	Refer to table provided under the row "Value(s) applied"
Additional comments	-

Compound	**Structure**	**Molar mass (kg/kmol)**	**Uncertainty (%)**
Nitrogen	N_2	28.014	0.0071
Oxygen	O_2	31.99	0.0063
Carbon monoxide	CO	28.01	0.0079
Hydrogen	H_2	2.016	0.021
Nitric oxide	NO	30.01	0.0047
Nitrogen dioxide	NO_2	46.01	0.0049
Sulfur dioxide	SO_2	64.06	0.034

9 See https://iupac.org/what-we-do/periodic-table-of-elements/.

Data / Parameter table 4.

Data/parameter	MM_{H_2O}
Description	Molecular mass of the water
Data unit	kg/kmol
Equations referred	(4), (8)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	18.015
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	The molecular masses of the elements H and O were sourced from the periodic table of elements published by the International Union of Pure and Applied Chemistry (IUPAC). The molar mass of H_2O was determined by multiplying the molecular mass of hydrogen by 2 and that of oxygen by 1
Treatment of uncertainties	Apply an uncertainty of 0.0060 per cent, calculated using the error propagation method applied to the uncertainty of the molecular masses of H and O, sourced from the periodic table of elements published by the International Union of Pure and Applied Chemistry (IUPAC)
Additional comments	-

Data / Parameter table 5.

Data/parameter	P_n
Description	Total pressure under normal conditions
Data unit	Pa
Equations referred	(2), (10), (11), (16)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	101,325
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	-
Treatment of uncertainties	N/A
Additional comments	-

Data / Parameter table 6.

Data/parameter	T_n
Description	Temperature under normal conditions
Data unit	K
Equations referred	(2), (10), (11), (16)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	273.15

Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	-
Treatment of uncertainties	N/A
Additional comments	-

6. Monitoring methodology

6.1. Data and parameters to be monitored

50. All monitored data must be time-linked, i.e., calculations shall be performed only with data acquired within the same time interval. As noted above, activity participants may use an hourly or smaller discrete time interval. Additional guidance is provided in the Appendix for monitoring the mass flow of methane in the biogas.

Data / Parameter table 7.

Data/parameter	$V_{t,wb}$	
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis	
Data unit	$m^3_{wet\ gas}/h$	
Equations referred	(7), (11)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology	
Measurement methods and procedures	Volumetric flow measurement shall always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analog or digital) are required	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	Periodic calibration shall be performed against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration shall follow the manufacturer's specifications
	Location	N/A
QA/QC procedures	As per the calibration requirements	

Treatment of uncertainties	Uncertainties are determined based on the measuring instruments
Additional comment	This parameter will be monitored in Options B and C

Data / Parameter table 8.

Data/parameter	$V_{t,db}$	
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis	
Data unit	$m^3_{dry\ gas}/h$	
Equations referred	(5), (7), (12)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology	
Measurement methods and procedures	Volumetric flow measurement shall always refer to the actual pressure and temperature. It shall be calculated based on the wet-basis flow measurement and water concentration measurement	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	Periodic calibration shall be performed against a primary device provided by an independent accredited laboratory. Calibration and frequency of calibration shall follow the manufacturer's specifications
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	This parameter will be monitored in Options A	

Data / Parameter table 9.

Data/parameter	$v_{i,t,db}$
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a dry basis
Data unit	$m^3_{gas\ i}/m^3_{dry\ gas}$
Equations referred	(5)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology

Measurement methods and procedures	Continuous gas analyser operating on a drybasis	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Continuous gas analyser operating on a drybasis
	Accuracy class	N/A
	Calibration requirements	Calibration shall include zero verification with an inert gas (e.g., N_2) and at least one verification reading with a standard gas (single or mixed calibration gas). All calibration gases shall be certified by the manufacturer and remain within their validity period
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	This parameter will be monitored in Options B and E and may be monitored in Options A and D	

Data / Parameter table 10.

Data/parameter	$v_{i,t,wb}$	
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a wet basis	
Data unit	$m^3_{gas\ i}/m^3_{wet\ gas}$	
Equations referred	(9)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology	
Measurement methods and procedures	Calculated based on dry-basis analysis and water concentration measurement, or measured directly using continuous in-situ analysers if not otherwise specified in the underlying mechanism methodology	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Continuous gas analyser operating on a drybasis
	Accuracy class	N/A
	Calibration requirements	Calibration shall include zero verification with an inert gas (e.g., N_2) and at least one verification reading with a standard gas (single or mixed calibration gas). All calibration gases must be certified by the manufacturer and remain within their validity period

	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	This parameter will be monitored in Options C and F and may be monitored in Options A and D	

Data / Parameter table 11.

Data/parameter	$M_{t,wb}$	
Description	Mass flow of the gaseous stream in time interval *t* on a wet basis	
Data unit	kg/h	
Equations referred	(14), (15), (16), (17)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology	
Measurement methods and procedures	Instruments with recordable electronic signals (analog or digital) are required	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration shall follow the manufacturer's specifications
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	This parameter will be monitored in Options E and F	

Data / Parameter table 12.

Data/parameter	$M_{t,db}$
Description	Mass flow of the gaseous stream in time interval *t* on a dry basis
Data unit	kg/h
Equations referred	(12), (13), (14)

Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology	
Measurement methods and procedures	Calculated based on the wet-basis flow measurement and water concentration measurement	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	Calibration and frequency of calibration shall follow the manufacturer's specifications
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	This parameter will be monitored in Option D	

Data / Parameter table 13.

Data/parameter	$C_{H_2O,t,db,n}$	
Description	Moisture content of the gaseous stream at normal conditions during time interval *t*	
Data unit	$mg_{H2O}/m^3_{dry\ gas}$	
Equations referred	(1)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	The mean value of three consecutive measurements performed on the same day (at least 2 hours each) shall be used. Measurements shall coincide with the Annual Surveillance Test (as required by the EN 14181 standard) or with the calibration of the flow meter for the gaseous stream	
Measurement methods and procedures	According to the USEPA CF42 method 4 – Gravimetric determination of water content	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	According to the USEPA CF42 method 4
	Accuracy class	According to the USEPA CF42 method 4
	Calibration requirements	According to the USEPA CF42 method 4

	Location	According to the USEPA CF42 method 4
QA/QC procedures	According to the USEPA CF42 method 4	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	Monitoring is required if Option 1, as described in Section 5.1 “Determination of the absolute humidity of the gaseous stream” of this methodological tool is applied, or, as one of the ways of proving that the gaseous stream is dry (necessary for Options A or D)	

Data / Parameter table 14.

Data/parameter	T_t	
Description	Temperature of the gaseous stream during time interval *t*	
Data unit	K	
Equations referred	(6), (11), (13)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous, unless otherwise specified in the underlying mechanism methodology	
Measurement methods and procedures	Instruments with recordable electronic signals (analog or digital) are required	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Thermocouples, thermo resistance, etc
	Accuracy class	N/A
	Calibration requirements	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer’s specifications
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be required except for moisture content determination. Therefore, it should be measured only when performing such measurements (at the same frequency). However, if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted, this parameter shall be monitored continuously to ensure the applicability condition is met	

Data / Parameter table 15.

Data/parameter	P_t	
Description	Pressure of the gaseous stream during time interval *t*	
Data unit	Pa	
Equations referred	(4), (6), (11), (13)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous unless otherwise specified in the underlying mechanism methodology	
Measurement methods and procedures	Instruments with recordable electronic signals (analog or digital) are required	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Pressure transducers, etc.
	Accuracy class	N/A
	Calibration requirements	Periodic calibration against a primary device shall be performed, and records of calibration procedures must be maintained along with the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) shall be calibrated monthly
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be required except for moisture content determination. Therefore, it should be measured only when performing such measurements (at the same frequency)	

Data / Parameter table 16.

Data/parameter	$p_{H_2O,t,sat}$
Description	Saturation pressure of H_2O at temperature T_t during time interval *t*
Data unit	Pa
Equations referred	(4)
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Measurement and updating frequency	
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature (T_t) and can be found in informative reference from paragraph 17(a) above for a total pressure equal to 101,325 Pa

Entity/person responsible for the measurement		
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	N/A	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	-	

Data / Parameter table 17.

Data/parameter	$v_{k,t,db}$	
Description	Volumetric fraction of gas *k* in the gaseous stream during time interval *t* on a dry basis	
Data unit	$m^3_{gas\ k}$ / $m^3_{dry\ gas}$	
Equations referred	(3)	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology or methodological tool	
Measurement methods and procedures	Continuous gas analyser operating on a dry basis	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Continuous gas analyser
	Accuracy class	N/A
	Calibration requirements	Calibration shall include zero verification with an inert gas (e.g., N_2) and at least one verification reading with a standard gas (single calibration or mixed calibration gas). All calibration gases shall be certified by the manufacturer and must remain within their validity period
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	-	

Data / Parameter table 18.

<table>
<tr><td>Data/parameter</td><td colspan="2">$v_{k,t,wb}$</td></tr>
<tr><td>Description</td><td colspan="2">Volumetric fraction of gas k in the gaseous stream during time interval t on a wet basis</td></tr>
<tr><td>Data unit</td><td colspan="2">$m^3_{gas\ k}$ / $m^3_{wet\ gas}$</td></tr>
<tr><td>Equations referred</td><td colspan="2">(17)</td></tr>
<tr><td>Purpose of data</td><td colspan="2">☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions</td></tr>
<tr><td>Measurement and updating frequency</td><td colspan="2">Continuous if not specified in the underlying mechanism methodology or methodological tool</td></tr>
<tr><td>Measurement methods and procedures</td><td colspan="2">Calculated based on the dry-basis analysis and water concentration measurement, or continuous in-situ analysers if not otherwise specified in the underlying mechanism methodology or methodological tool</td></tr>
<tr><td>Entity/person responsible for the measurement</td><td colspan="2">Activity participants</td></tr>
<tr><td rowspan="4">Measuring instrument(s)</td><td>Type of instrument</td><td>Continuous gas analyser</td></tr>
<tr><td>Accuracy class</td><td>N/A</td></tr>
<tr><td>Calibration requirements</td><td>Calibration shall include zero verification with an inert gas (e.g., N_2) and at least one verification reading with a standard gas (single calibration or mixed calibration gas).
All calibration gases shall be certified by the manufacturer and remain within their validity period</td></tr>
<tr><td>Location</td><td>N/A</td></tr>
<tr><td>QA/QC procedures</td><td colspan="2">As per the calibration requirements</td></tr>
<tr><td>Treatment of uncertainties</td><td colspan="2">Uncertainties are determined based on the measuring instruments</td></tr>
<tr><td>Additional comment</td><td colspan="2">-</td></tr>
</table>

Data / Parameter table 19.

Data/parameter	**Status of biogas destruction device**
Description	Operational status of biogas destruction devices
Data unit	-
Equations referred	
Purpose of data	☒ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Measurement and updating frequency	Continuous if not specified in the underlying mechanism methodology or methodological tool
Measurement methods and procedures	Monitoring and documenting may be undertaken by recording the energy production from methane captured or by monitoring flare operation using a flame detector to confirm actual methane destruction unless another method is specified in the underlying mechanism methodology or methodological tool.

	Emission reductions shall not accrue for periods in which the destruction device is not operational	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures	As per the calibration requirements	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	For Flame detector devices, refer to the flaring tool	

Appendix. Additional data handling and monitoring guidance for determining the mass flow of methane in biogas

1. This appendix is applicable to the determination of mass flow of methane in biogas from waste treatment and landfill gas.

1. Data substitution for methane content or biogas flow

2. If missing data are encountered in the course of determining the methane mass flow, they may be substituted with conservative data sets (see below) from specific periods. However, data substitution shall only be applied to either the methane concentration or the biogas volumetric flow readings, but not to both simultaneously. If data are missing for both parameters during a given period, no data substitution shall be allowed for that period.

3. Substitution, as outlined in Table below, may be undertaken only if the following conditions are met:

(a) For methane concentration, biogas flow rates during the period where the data gap occurred (data gap period) shall be consistent with normal operation (i.e., the average flow rates during the gap period shall not deviate from the average flow rates of the period taken for data substitution (data substitution period)[1] by more than +/- 20 per cent); and

(b) For biogas flow rate, methane concentration during the data gap period shall be consistent with the methane concentration observed during normal operations (i.e., the average methane concentration during the data gap period shall not deviate from the average methane concentration of the data substitution period by more than +/- 20 per cent); and

(c) Activity participants shall demonstrate that the methane is being destroyed during the data gap period. If corroborating parameters fail to demonstrate any of these requirements, no substitution shall be allowed.

Table . Data substitution procedure

Duration of Missing Data	Data Substitution procedure
Less than six hours	Use the weighted average of the four-hour period immediately before and the four-hour period immediately after the outage
Six to 24 hours	Use the upper bound or lower bound of the 95per cent confidence interval of the data spanning 24 hours prior to and 24 hours after the outage, whichever results in a more conservative estimate of emission reductions
One to seven days	Use the upper bound or lower bound of 95 per cent confidence interval of the data spanning 72 hours prior to and 72 hours after the outage, whichever results in a more conservative estimate of emission reductions
Greater than one week	No data may be substituted

[1] The data substitution period is determined as detailed in the data substitution procedure in table.

2. Use of a single flow meter for multi-use of recovered biogas

4. If the recovered biogas (e.g., landfill gas) 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 detector records, or energy generated records), 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 applied to all destruction devices monitored by this flow meter.

5. If there are any periods during which one or more destruction devices are not operational, emission reductions from methane destruction for these periods may be claimed, provided that verification confirms the fulfilment of all the following conditions. In such a case, the destruction efficiency of the least efficient destruction device in operation shall be applied to all destruction devices monitored by this single flow meter:

    (a) All destruction devices are either equipped with valves on the input gas line that close automatically (e.g., normally closed valves) if the device becomes non-operational (i.e., requiring no manual intervention), or are designed such that it is physically impossible for the gas to pass through into the atmosphere while the device remains non-operational; and

    (b) For any period during which one or more destruction devices within this arrangement are not operational, it shall be demonstrated that the remaining operational devices have the capacity to destroy the actual gas flow recorded during the period. For devices other than flares, it shall be shown that the output corresponds to the flow of gas (e.g., through mass and/or energy balance).

6. Measurement of methane content shall be carried out immediately downstream of the flow meter, in accordance with the installation requirements of the flow meter.

3. Use of a sampling method for methane content of landfill gas

7. Methane content of landfill gas may be monitored by sampling, provided that the following conditions are met:

    (a) The maximum waste treatment capacity of the landfill is 200 tonnes of waste per day; and

    (b) The standard “Sampling and surveys for Article 6.4 activities” (still to be adopted by the Supervisory Body) is applied for conducting sampling, with a minimum frequency of two samples per week; and

    (c) National or international protocols for measuring methane content of biogas by semi-continuous analysis shall be followed; otherwise, meter readings should only be collected when the methane content has stabilized for at least 3 minutes. Orsat analysis is not eligible; and

    (d) The biogas flow rate is monitored continuously. The methane content measured by sampling for a given period shall be used directly only if the average flow rate during the following week does not fluctuate by more than +/- 20 per cent compared to the mean value of the flow rates for the period during which the methane content was measured by sampling. Otherwise, a conservative adjustment shall be applied to the measured methane content, i.e., by applying the observed deviation as a discounting factor.

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Document information

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