CLEAN DEVELOPMENT MECHANISM
SMALL-SCALE PROGRAM ACTIVITY DESIGN DOCUMENT FORM (CDM-SSC-CPA-DD)
Version 01

CONTENTS

Annexes

NOTE:

(i) This form is for submission of CPAs that apply a small scale approved methodology using the provision of the proposed small scale CDM PoA.

(ii) The coordinating/managing entity shall prepare a CDM Small Scale Programme Activity Design Document (CDM-SSC-CPA-DD)[1,2] that is specified to the proposed PoA by using the provisions stated in the SSC PoA DD. At the time of requesting registration the SSC PoA DD must be accompanied by a CDM-SSC CPA-DD form that has been specified for the proposed SSC PoA, as well as by one completed CDM-SSC CPA-DD (using a real case). After the first CPA, every CPA that is added over time to the SSC PoA must submit a completed CDM-SSC CPA-DD.

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[1] The latest version of the template form CDM-CPA-DD is available on the UNFCCC CDM web site in the reference/document section.

[2] At the time of requesting validation/registration, the coordinating managing entity is required to submit a completed CDM-POA-DD, the PoA specific CDM-CPA-DD, as well as one of such CDM-CPA-DD completed (using a real case).

SECTION A. General description of small scale CDM programme activity (CPA)

{Sections in these brackets describe passages that have to be deleted or kept according to case}

A.1. Title of the small-scale CPA:

CPA-ID: [landfill project name]
Version 1
DD/MM/YYYY

A.2. Description of the small-scale CPA:

The present CPA is to be implemented as part of the CDM PoA "Programme for the Capture and Destruction or Utilization of Landfill Gas in Colombia". The PoA aims primarily at avoiding methane emissions from landfills in Colombia but also offers the option for emission reductions from the utilization of landfill gas (LFG).

[Brief description of CPA; describe components of the PoA that are relevant for this CPA; describe landfill (waste quantities, period during which waste has been deposited, waste origin, date of closure of landfill if applicable, remaining volume of landfill if applicable, etc.)]

The CPA can be summarised as follows:

- {EITHER: Implementation of a LFG collection and destruction system comprising of collection piping and gas wells and a flaring system at the [landfill name] };
- {OR: Implementation of a LFG collection system and utilization of the captured LFG for [utilization mode(s)] in combination with flaring of excess biogas. In terms of emission reduction the CPA thus comprises of two components.
  Component 1: Avoidance of methane emissions to the atmosphere due to the decay of organic matter in landfills. The emission is avoided by capturing of landfill gas and its destruction through flaring or combustion.
  Component 2: Generation of renewable energy from captured LFG. The emission is avoided by displacing fossil fuels and/or grid electricity.}

[In case of phased implementation of components 1 and 2, please describe the implementation schedule]

Contributions to sustainable development
In this CPA, the baseline scenario consists in the release of huge amounts of GHG emissions to the atmosphere, further contributing to global warming and its consequences. The released GHGs are mainly methane, a rather powerful greenhouse gas with a global warming potential of 21 (GWP_{100}). The implementation of the CPA will reduce the release of methane emissions from landfills by around 50%.

Main technology components installed due to the project activity will be imported to Colombia. The project activity is thus a good example of technology transfer. After the installation of the technology, qualified personnel will be necessary for the operation and maintenance of the installed equipment and for the monitoring of the landfill gas collection.

A.3. Entity/individual responsible for the small-scale CPA:

The implementing and operating entity of the CPA will be CarbonBW Colombia S.A.S (CarbonBW). CarbonBW will also serve as Coordinating and Managing Entity of the PoA.

A.4. Technical description of the small-scale CPA:

Out of the potential components defined in the PoA, CPA-[ID] includes the following components:

YES	NO	Component
x	-	LFG capture
[x]	[x]	LFG destruction with enclosed flare
[x]	[x]	Utilization of LFG for direct electricity generation with flaring of excess gas
[x]	[x]	Utilization of LFG for direct heat generation with flaring of excess gas
[x]	[x]	Utilization of LFG for direct heat and electricity generation with flaring of excess gas
[x]	[x]	Utilization of LFG without claiming CERs for emissions reduced due to the utilization of the renewable fuel "LFG"

Accordingly the following technology will be applied by the CPA:

{In case LFG will also be utilized: COMPONENT 1}

1. **Landfill gas collection system**

State-of-the-art gas collection technology to be included in this CPA includes the items listed below:

- Vertical and horizontal gas wells equipped with wellheads for measurements;
- Connection tubes between gas wells and flaring station. These systems are usually designed as modular system in order to allow for future extension in case of open landfills;
- Leachate monitoring in selected extraction wells: Leachate levels in extraction wells will be measured and recorded regularly. In the event of elevated leachate levels, wells might be dewatered by pumps.

2. **Flaring system**

In order to ensure high standard gas destruction efficiencies, state-of-the-art gas flares will be applied as listed:

- [Number] of electric blower at [x] kW to create suction at inlet for LFG extraction and pressure at outlet for flare operation;
- Enclosed flare to ensure highest efficiency in flaring. Flaring temperature is above [degrees] °C under normal operation conditions. The flare accepts methane concentrations between [min CH4-conc.]% and [max CH4-conc.]%. The flaring efficiency is above 99% under normal operation conditions;
- Web-based remote supervision and control of the flare; and

- Security restart system in case of system shut down.

{In case LFG will also be utilized: COMPONENT 2 }
{In case of LFG utilization for direct electricity generation keep point 3, else delete:

3. Electricity generation system
- Gas drying equipment to remove moisture from gas before combustion;
- Gas cleaning equipment of the type [xxxx] to remove impurities especially sulphur;
- [xx] kW gas engine from [manufacturer];
- Power generator driven by the gas engine;}
- {In case of grid connection for export of surplus electricity: a substation with grid connection and transformer to increase voltage}.

{In case of LFG utilization for direct heat generation keep point 4, else delete:

4. Direct heat generation system
- Gas drying equipment to remove moisture from gas before combustion;
- Gas cleaning equipment (e.g. activated carbon) to remove impurities especially sulphur;
- [xx] GJ [type of heat generation equipment like boiler].}

{In case of LFG utilization for direct heat and electricity generation keep point 5, else delete:

5. Direct heat and electricity generation system
- Gas drying equipment to remove moisture from gas before combustion;
- Gas cleaning equipment (e.g. activated carbon) to remove impurities especially sulphur;
- [type of co-generation system mentioning heat and power output nameplate capacities];
- {In case of grid connection for export of surplus electricity: A substation with grid connection and transformer to increase voltage}}.

{In case of other LFG utilization modes not described above describe type of technology used}

Monitoring system:
The LFG collection and utilization system will include instrumentation that allows the accurate measurement of the captured and destroyed LFG. Monitoring and control will be with automatic flow meters, thermocouples on the flare, gas analyzers for inflow and exhaust gas, sampling points in the tubular system, and an internet based system for monitoring and remote control. Data transmission will be via the web (online) and storage on computer servers.

A.4.1. Identification of the small-scale CPA:

CPAs under the PoA "Programme for the Capture and Destruction or Utilization of Landfill Gas in Colombia" are stationary and are not mobile devices. A clear identification via geo-coordinates is thus possible.

A.4.1.1. Host Party:

Colombia

A.4.1.2. Geographic reference or other means of identification allowing the unique identification of the small-scale CPA (maximum one page):

The project boundary of the CPA comprises of the [landfill name] landfill. This landfill is located in:

- the district of [name of district]
- in the province of [name of district]

A unique identification of the landfill is possible via the following geo-coordinates:
[GPS Coordinates]

[Insert map showing project site and surrounding area]

{In case the project boundary includes LFG utilization activity where the site of energy recover is not located at the landfill site complete the following section, else delete:
The project boundary of the CPA further includes the project site where energy is recovered. This site can be identified via the following geo-coordinates:
[GPS coordinates of the facilities] }

{In case the CERs from LFG utilization activity are not accounted for although there is a LFG utilization activity, else delete:
The project boundary of the CPA does not include the facilities where LFG will be utilized, but only the distribution points. CERs are not claimed from this activity. However, revenues from such activities (e.g. sale of LFG) are accounted for in the assessment of additionality. This proceeding is conservative. }

A.4.2. Duration of the small-scale CPA:

A.4.2.1. Starting date of the small-scale CPA:

[CPA starting date DD/MM/YYYY]

A.4.2.2. Expected operational lifetime of the small-scale CPA:

[CPA operational lifetime in years]

A.4.3. Choice of the crediting period and related information:

[EIHTER] Renewable crediting period
[OR] Fixed Crediting period

A.4.3.1. Starting date of the crediting period:

[Starting date of the crediting period: DD/MM/YYYY]

A.4.3.2. Length of the crediting period, first crediting period if the choice is renewable CP:

The length of the crediting period is limited to the end date of the PoA regardless of when the CPA was included.

[End date of the crediting period: DD/MM/YYYY– Depending on the choice in Section A.4.3. either 7 or 10 years]

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

Year	**Total Annual estimation of emission reductions in tonnes of CO_2e**
Year 1	[xx]
Year 2	[xx]
Year 3	[xx]
Year 4	[xx]
Year 5	[xx]
Year 6	[xx]
Year 7	[xx]
Year 8	[xx]
Year 9	[xx]
Year 10	[xx]
Total estimated reduction (tonnes of CO_2e)	[xx]
Total number of crediting years	[7 or 10]
Annual average over the crediting period of estimated reduction (tonnes of CO_2e)	[xx]

A.4.5. Public funding of the CPA:

[Public funding information for this CPA]

A.4.6. Information to confirm that the proposed small-scale CPA is not a de-bundled component

The proposed project activity is not deemed to be a de-bundled component of a large scale activity as there is no other activity (registered small-scale CPA, an application to register another small-scale CPA, or another registered CDM project activity) that fulfils the two following criteria at the same time:

YES	NO	Component

[x]	[x]	There is no other activity which has the same CME (CarbonBW) which also manages a large-scale PoA of the same sectoral scope.
[x]	[x]	There is no other activity of which the boundary is within 1 km of the boundary of the proposed CPA (at the closest point).

Only if both above criteria would be fulfilled by the CPA, the proposed small-scale CPA would be a de-bundled component of a large-scale activity. In this case the regulations set out in Annex II of the decision 4/CMP.1 and 5/CMP.1 would be followed

The Coordinating and Managing Entity, CarbonBW Colombia S.A.S., confirms that the CPA is neither registered as an individual CDM project activity nor is part of another registered PoA. In this context available information from the UNFCCC website and the list of registered CDM project activities serves as additional evidence. The unique identification via the geo-coordinates indicated above can thereby referred to.

A.4.7. Confirmation that small-scale CPA is neither registered as an individual CDM project activity or is part of another Registered PoA:

It is confirmed that the SSC_CPA is neither registered as an individual CDM project activity or is part of another registered PoA.

SECTION B. Eligibility of small-scale CPA and Estimation of emissions reductions

B.1. Title and reference of the Registered PoA to which small-scale CPA is added:

Programme for the Capture and Destruction or Utilization of Landfill Gas in Colombia

B.2. Justification of the why the small-scale CPA is eligible to be included in the Registered PoA :

The CPA is eligible to be included in the PoA as it fulfils all eligibility criteria listed in the following:

YES	NO	Criterion
[x]	[x]	Open or closed landfill for household/urban waste.
[x]	[x]	For the landfill gas, the baseline scenario consists of the total or partial release of LFG to the atmosphere.
[x]	[x]	Document(s) signed by the landfill owner confirming: a) the voluntary involvement in the PoA, b) his right for the utilization of the LFG, c) assignment of the right for landfill gas capture including its potential utilization to CarbonBW (the CME), and d) the assignment of the right for construction and installation of necessary equipment for a LFG capture and flaring and/or potential utilization.

[x]	[x]	Confirmation in the CPA-DD that the activity under the CPA is neither registered as an individual CDM project activity nor included as part of another registered PoA.
[x]	[x]	Document signed by the landfill owner confirming that: - the planned activity did not receive benefits through ODA; - no (financial) commitments to install the planned project activity before signing the agreement with the CME had been made.
[x]	[x]	The landfill keeps the Environmental Norms of Colombia (e.g. Law 99/93) and provides the relevant documents.
[x]	[x]	The landfill where the waste is deposited can be clearly identified.
[x]	[x]	The boundary of the landfill is not within 1 km (at its closest point) from another landfill gas activity registered within the last two years or requesting registration.
[x]	[x]	Landfill gas from hazardous waste cells (if any) is not included in the capture system.
[x]	[x]	The *ex-ante* calculated emission reduction due to methane destruction from the landfill is limited to 60 ktCO_2e/year.
[x]	[x]	Stakeholder consultation requirements are followed as per the DNA of the host country.
[x]	[x]	Additionality has been confirmed according to the below defined additionality eligibility criteria.

Data on the potential start date of the CPA and the technical specifications will be provided by the CME to the DOE.

{In case the CPA includes LFG utilization for direct energy recovery, then edit the following table, else delete it:
For the LFG utilization further eligibility criteria are relevant that are also complied by the CPA.

YES	NO	Criterion
[x]	[x]	If LFG is sold by CarbonBW (the CME) to third parties for utilization in direct electricity and/or heat generation, a contract will be entered into that ensures that there is no double-counting of emission reductions.
[x]	[x]	The aggregate installed capacity is below 45 MW_{th} for heat or co-generation activities, or respectively 15 MW_{el} for electricity only activities.
[x]	[x]	In case of electricity displacement, electricity is not displaced from a mini-grid system.
[x]	[x]	Displaced energy generation would not be in a co-fired (i.e. biomass and fossil fuels) system.
[x]	[x]	The renewable energy generation unit installed due to the project activity is not a capacity addition to an existing energy generation plant.
[x]	[x]	The energy baseline excludes the generation of thermal and/or electrical energy, partially or totally, based on biomass.
[x]	[x]	In case the project activity retrofits an existing plant, the existing plant is operated exclusively on fossil fuels.

}

{In case the CPA includes LFG utilization activities for which no CERs are claimed, then edit the following table, else delete it:

For the LFG utilization a further eligibility criterion is relevant. For the described LFG utilization activity no CERs will be claimed. The eligibility criterion is complied by the CPA. It is thus eligible to be included into the PoA.

YES	NO	Criterion
[x]	[x]	If LFG is sold by CarbonBW (the CME) to third parties, a contract will be entered into that ensures that no CERs are claimed for the utilization of the LFG.

}

B.3. Assessment and demonstration of additionality of the small-scale CPA , as per eligibility criteria listed in the Registered PoA:

CPA-[XX] is additional as per the eligibility criteria listed in the PoA. The following additionality criteria defined have been verified:

- {ERASE IF LFG IS UTILIZED: The CPA only captures and flares landfill gas. There is no utilization of landfill gas and thus revenues other than CERs are not generated. As the capture and flaring of LFG is not stipulated by national or regional regulations in Colombia, the CPA is deemed additional. }
- [ERASE IF LFG IS ONLY FLARED AND NOT UTILIZED: Describe the results of the investment analysis in which the indicator NPV was applied. Mention the consideration period, the discount factor, investment costs, O&M costs, and the lifetime of equipment. Describe the results of the sensitivity analysis. Conclude if the CPA is additional based on the criterion of a negative NPV for the investment analysis including the sensitivity analysis. Describe also precisely the starting and ending dates of this activity, in case the utilization is not simultaneously with the gas capture in the project activity.]

B.4. Description of the sources and gases included in the project boundary and proof that the small-scale CPA is located within the geographical boundary of the registered PoA.

The CPA is located within the geographical boundary of the registered PoA. This can be proven easily as the geographical boundary encompasses the national borders of the Republic of Colombia, the host party, and the proposed CPA is located in the Republic of Colombia.

Table: Summary of Gases and Sources included in the Project Boundary

	Source	Gas	Included?	Justification/Explanation
Baseline	Atmospheric emissions from decomposition of waste at the landfill site	CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
Project	Emissions from power consumption by project facilities	CO_2	Yes	The major source of emissions in the project activity.
		CH_4	No	Excluded for simplification. This emission

				source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

{Include the following table in case LFG is utilized for direct energy recovery (power, or heat, or power and heat generation) and this activity is included in the project boundary, i.e. CERs are claimed for this activity, else delete the table:

Table: Summary of gases and sources included in the project boundary of Scenario 2

	Source	Gas	Included?	Justification/Explanation
Baseline	Atmospheric emissions from decomposition of waste at the landfill site	CH_4	Yes	Main emission source in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
	Fossil fuel combustion for energy generation (grid electricity and captive generation)	CO_2	Yes	Main emission source in the baseline.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project	Emissions from power consumption by project facilities	CO_2	Yes	Major emission source in the project activity.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Fossil fuel combustion	CO_2	Yes	Major emission source in the project activity.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

}

B.5. Emission reductions:

BASELINE EMISSIONS [In case LFG is also utilized and CERs claimed for this activity: "OF COMPONENT 1"]

For the avoidance of methane emissions from the landfill due to the capture and combustion of landfill gas the following formulae are applied in line with AMS-III.G to calculate the annual baseline emissions (BE_y):

$$BE_y = BE_{CH4,SWDS,y} - MD_{reg,y} \cdot GWP_{CH4}$$

$MD_{reg,y}$ was set to zero for all CPAs. Thus:

$MD_{reg,y}$ = 0 tCH_4

$BE_{CH4,SWDS,y}$ is calculated according to the following formula:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_j W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot (1-e^{-k_j})$$

$BE_{CH4,SWDS,y}$	Baseline emissions of methane avoided during the year *y* at the solid waste disposal site during the period from the start of the project activity to the end of the year *y* (tCO_2e)
φ	Model correction factor to account for model uncertainties
f	Fraction of methane captured in the baseline at the solid waste disposal site (SWDS) and flared, combusted or used in another manner
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose
MCF	Methane correction factor (fraction)
$W_{j,x}$	Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
DOC_j	Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j	Decay rate for the waste type *j*
j	Waste type
y	Year for which methane emissions are calculated

In line with the PoA the fixed values for the parameters φ, f, F, and DOC_f are copied to the CPA:

φ = 0.9
f = 0.0
F = 0.5
DOC_f = 0.5

The landfill is covered with [describe the cover material of the landfill and if it qualifies as oxidizing material according to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. If it is oxidizing material apply a value of 0.1. For other material apply a value of 0.0].
Therefore:
OX = [0.0 or 0.1]

In line with the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site“, the landfill qualifies as [either “anaerobic managed SWDS”, or “semi-aerobic managed SWDS”, or “unmanaged SWDS”, or “unmanaged shallow SWDS”]. Accordingly the value for the Methane Correction Factor (MCF) has been set to:
MCF = [1.0 or 0.5 or 0.8 or 0.4]

The amount of waste and the amount of waste per waste type *j* has been sampled [mention name of laboratory and number of samples if available]. The composition of the waste is the following:

Waste type *j*	**Shares of Waste Types (wet) (%)**
Wood and wood products	[xx]
Pulp, paper and cardboard (other than sludge)	[xx]
Food, food waste, beverages and tobacco (other than sludge)	[xx]
Textiles	[xx]
Garden, yard and park waste	[xx]
Glass, plastic, metal, other inert waste	[xx]
TOTAL	100.0

The decay rate according to waste type *j* (k_j) and the fraction of degradable organic carbon in the waste type *j* has been selected in line with AMS-III.G.

Therewith all parameters for the calculation of the baseline emissions from the solid waste disposal site are available. The calculation of the BE_y for the avoidance of methane emissions from solid waste disposal sites (landfills) can be traced in the attached MS-Excel calculation file.

[The section “Baseline Emissions of Component 2” is only for the case of any of scenarios 2 is relevant to the CPA; else erase]

<u>BASELINE EMISSIONS OF COMPONENT 2</u>

[Insert a short description in tabular form of the quantities of LFG from which energy will be recovered either as share or total LFG per year or as energy generation in GJ and/or MWh per year also indicating the load factor of energy generation equipment and available energy generation capacity]

{Following sub-section only in case LFG will be utilized for direct electricity generation (in electricity-only mode and CERs claimed for this activity; no co-generation:
For the installed [type of technology] the baseline emissions can be calculated as follows:

$$BE_y = EG_{BL,y} \cdot EF_{CO_2,grid,y}$$

BE_y	Baseline Emissions in year *y* (tCO_2e)
$EG_{BL,y}$	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{CO2,grid,y}$	CO_2 emission factor of the grid in year *y* (tCO_2e/MWh)

The project activity displaces [EITHER "grid electricity" OR "captive power generation"].
}

{In case all electricity displaced is from the grid:
The emission factor according to the "Tool to calculate the Emission Factor for an electricity system" is set by the Colombian Ministry for Mines and Energy to the value of:

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}
}

{In case all electricity displaced is from (a) captive power plant(s):
The emissions factor for captive power generation is calculated based on the historic data from the most recent [value smaller or equal to three] years before the implementation of the project activity, i.e. the displacement of the captive power plant, applying the following formula:

$$EF_{CO2,grid,y} = \frac{\sum_{n}\sum_{i} FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{n} EG_{n,y}}$$

$FC_{n,i,y}$	Quantity of fossil fuel type *i* fired in the captive power plant *n* in the year *y* (mass or volume unit)
$NCV_{i,y}$	Net Calorific Value of fossil type *i* used in the year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* used in the year *y* (tCO_2/GJ)
$EG_{n,y}$	Quantity of electricity generated in captive power plant *n* in the time year *y* (MWh)
y	Year of the most recent three years prior to project implementation

}

{In case electricity from both captive power plants and grid is displaced; project activity is not greenfield:
As the emission factor should reflect the emissions intensity of the grid and the captive power plant in the baseline scenario as weighted average, it is necessary to calculate both emission factors. Thereby the following calculations have been made:
The emission factor of the displaced grid electricity is set by the Colombian Ministry for Mines and Energy.

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}

The emissions factor for captive power generation is calculated based on the historic data from the most recent [value smaller or equal to three] years before the implementation of the project activity applying the following formula:

$$EF_{CO2,grid,y} = \frac{\sum_n \sum_i FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_n EG_{n,y}}$$

$FC_{n,i,y}$	Quantity of fossil fuel type *i* fired in the captive power plant *n* in the year *y* (mass or volume unit)
$NCV_{i,y}$	Net Calorific Value of fossil type *i* used in the year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* used in the year *y* (tCO_2/GJ)
$EG_{n,y}$	Quantity of electricity generated in captive power plant *n* in the time year *y* (MWh)
y	Year of the most recent three years prior to project implementation

For the *ex-ante* calculation of the weighted average emission factor the following generation shares are assumed.

Year	Project Generation (EG)	Share of Grid in BL	Share of Captive Power in BL
all years	[xx] GWh	[yy]%	[zz]%

{add years if different in each year}

The emission factor is thus:

$EF_{CO2,grid,y}$ = [yy]%*0.2849tCO_2e/MWh {update as applicable} + [zz]%*tCO_2e/MWh
= [xx] tCO_2e/MWh

}

{In case electricity from both captive power plants and grid is displaced; project activity is greenfield:

The emission factor should be the lower of the two emission factors for grid electricity and for electricity generated in (a) captive power plant(s).

The first, the emission factor of the displaced grid electricity is set by the Colombian Ministry for Mines and Energy.

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}

The second, the emissions factor for captive power generation is calculated based on the historic data from the most recent [value smaller or equal to three] years before the implementation of the project activity applying the following formula:

$$EF_{CO2,grid,y} = \frac{\sum_n \sum_i FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_n EG_{n,y}}$$

$FC_{n,i,y}$	Quantity of fossil fuel type *i* fired in the captive power plant *n* in the year *y* (mass or volume unit)
$NCV_{i,y}$	Net Calorific Value of fossil type *i* used in the year *y* (GJ/mass or volume unit)

$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* used in the year *y* (tCO_2/GJ)
$EG_{n,y}$	Quantity of electricity generated in captive power plant *n* in the time year *y* (MWh)
y	Year of the most recent three years prior to project implementation

The emission factor is thus:

$EF_{CO2,grid,y}$ = MIN(0.2849 tCO_2e/MWh {update as applicable}, [xx] tCO_2e/MWh)
= [xx] tCO_2e/MWh

}

{Following sub-section only in case LFG will be utilized for direct heat generation (in heat-only mode; no co-generation) and CERs claimed for this activity:
The emission reduction due to the fossil fuel based steam/heat production is calculated as follows:

$$BE_{thermal,CO2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO2}$$

$BE_{thermal,CO2,y}$	Baseline emissions from steam/heat displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	Net quantity of steam/heat supplied by the project activity during the year *y* (TJ)
$EF_{FF,CO2}$	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available, alternatively, IPCC default emission factors can be used (tCO_2/TJ)
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

{If historic efficiency values are available: The baseline emissions are calculated based on the average efficiency of heat/steam generation during the most recent [value smaller or equal to three] years. }
{If historic efficiency values are not available: The baseline emissions are calculated based on the efficiency determined by a performance test that was done before the project implementation. }
}

{For heat only and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity.
}

{Following sub-section only in case LFG will be utilized for direct heat and power generation (co-generation) and CERs claimed for this activity:
The emission reduction is achieved due to the displacement of fossil fuel combustion in heat and power generation. This baseline corresponds to one of the following baseline scenarios described in AMS-I.C (remark: this refers to the baseline scenario not the project scenario):

Y/N	Scen	Electrical Energy	Thermal Energy (heat/steam)
[x]	A	grid import	fossil fuel

[x]	B	fossil fuel	fossil fuel
[x]	C	grid import & fossil fuel	fossil fuel
[x]	D	cogeneration (fossil fuel)	cogeneration (fossil fuel)

{If baseline scenario is fossil fuel based generation of electricity in a captive power plant:

$$BE_{captelec,y} = (EG_{captelec,PJ,y} / \eta_{BL,captive\ plant}) * EF_{BL,FF,CO_2}$$

$BE_{captelec,y}$	Baseline emissions from captive electricity displaced by the project activity during the year *y* (tCO_2)
$EG_{captelec,PJ,y}$	Amount of electricity produced by the project activity during the year *y* (MWh)
EF_{BL,FF,CO_2}	CO_2 emission factor of the fossil fuel that would have been used in the baseline plant (tCO_2/MWh)
$\eta_{BL,captive\ plant}$	Efficiency of the captive plant using fossil fuel that would have been used in the absence of the project activity

}

{If historic efficiency values are available: The baseline emissions are calculated based on the average efficiency of heat/steam generation during the most recent [value smaller or equal to three] years.}
{If historic efficiency values are not available: The baseline emissions are calculated based on the efficiency determined by a performance test that was done before the project implementation.}
}

{For captive, fossil fuel based power generation and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{BL,FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity.
}

{If baseline scenario is grid import and/or export of electricity:

$$BE_y = EG_{BL,y} \cdot EF_{CO2,grid,y}$$

BE_y	Baseline Emissions in year *y* (tCO_2e)
$EG_{BL,y}$	Quantity of net electricity supplied to the grid by the project activity in year *y* (MWh)
$EF_{CO2,grid,y}$	CO_2 emission factor of the grid in year *y* (tCO_2e/MWh)

The emission factor of the displaced grid electricity is set by the Colombian Ministry for Mines and Energy. The most recent value is:

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}
}

{If baseline scenario is grid export of electricity:

$$BE_y = EG_{BL,y} \cdot EF_{CO_2,grid,y}$$

BE_y	Baseline Emissions in year *y* (tCO_2e)
$EG_{BL,y}$	Quantity of net electricity supplied to the grid by the project activity in year *y* (MWh)
$EF_{CO2,grid,y}$	CO_2 emission factor of the grid in year *y* (tCO_2e/MWh)

The emission factor of the displaced grid electricity is set by the Colombian Ministry for Mines and Energy. The most recent value is:

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}
}

{If the baseline is captive electricity generation and/or displacement of grid electricity import and/or supply of electricity to a grid and existing plants are displaced:
The emission factor reflects both the emission intensity of the captive power plant and the grid. The annual electricity production in the project activity ($EG_{BL,y}$) will be compared to:

(A) On-site captive electricity generation (in the most recent years before the project implementation);
(B) Electricity import minus the electricity export (in the most recent years before the project implementation).

If (A) + (B) $\leq EG_{BL,y}$ then the emission factor is calculated as the weighted average of on-site captive electricity generation and the net grid electricity import in the baseline.

If (A) + (B) > $EG_{BL,y}$ then the lower of the two emission factors i.e. the emission factor of the grid or the emission factor of the baseline captive plant is used for the incremental generation.
}

{If the baseline is captive electricity generation and/or displacement of grid electricity import and/or supply of electricity to a grid and there are no existing plants that are displaced:
As the project plant is a new plant, the emission factor reflects the lower of the emission intensity of the baseline captive power plant and the grid.
}

{If baseline scenario is fossil fuel based generation of heat/steam:

$$BE_{thermal,CO_2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO_2}$$

$BE_{thermal,CO2,y}$	Baseline emissions from steam/heat displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	Net quantity of steam/heat supplied by the project activity during the year *y* (TJ)
$EF_{FF,CO2}$	CO_2 emission factor of the fossil fuel that would have been used in the baseline plant (tCO_2/TJ)
$\eta_{BL,thermal}$	Efficiency of the plant using fossil fuel that would have been used in the absence

of the project activity

{If historic efficiency values are available: The baseline emissions are calculated based on the average efficiency of heat/steam generation during the most recent [value smaller or equal to three] years.}
{If historic efficiency values are not available: The baseline emissions are calculated based on the efficiency determined by a performance test that was done before the project implementation.}

}

{For fossil fuel based generation of heat/steam and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity. }

{If baseline scenario is the fossil fuel based co-generation of power and heat/steam (co-generation); Remark: Greenfield activities were excluded for this activity:
This baseline corresponds to baseline scenario (D) described in AMS-I.C. The following formula has been used to determine baseline emissions:

$$BE_{cogen,CO_2,y} = [(EG_{PJ,thermal,y} + EG_{PJ,electrical,y} * 3.6) / \eta_{BL,cogen}] * EF_{FF,CO_2}$$

$BE_{cogen,CO2,y}$	Baseline emissions from electricity and thermal energy displaced by the project activity during the year *y* (tCO_2)
$EG_{PJ,electrical,y}$	Amount of electricity supplied by the project activity during the year *y* (GWh)
3.6	Conversion factor (TJ/GWh)
$EG_{PJ,thermal,y}$	Net quantity of thermal energy supplied by the project activity in the year *y* (TJ)
$EF_{FF,CO2}$	CO_2 emission factor of the fossil fuel that would have been used in the baseline cogeneration plant (tCO_2/TJ)
$\eta_{BL,cogen}$	Average efficiency of the cogeneration plant using fossil fuel

}

{If historic efficiency values are available: The baseline emissions are calculated based on the average efficiency of heat/steam generation during the most recent [value smaller or equal to three] years.}
{If historic efficiency values are not available: The baseline emissions are calculated based on the efficiency determined by a performance test that was done before the project implementation.}

{For fossil fuel based co-generation in the baseline and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity.}

PROJECT EMISSIONS [In case LFG is also utilized and CERs claimed for this activity: "OF COMPONENT 1"]

Project emissions comprise of CO_2-emissions related to the power or electricity consumption by the project activity facilities, emissions from flaring or combustion of the gas stream, or emissions from the landfill gas upgrading process. As the latter is not relevant to this PoA project emissions can be calculated as follows:

$$PE_y = PE_{power,y} + PE_{flare,y}$$

$PE_{power,y}$	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in year *y* (tCO_2e)
$PE_{flare,y}$	Emission from flaring or combustion of the landfill gas stream in the year *y* (tCO_2e)

Project emissions from power consumption are according to the procedures described in AMS-I.D:

$$PE_{power,y} = EC_y \cdot EF_{grid,CO2,y}$$

Where:

PE_y	Project emissions during the year *y* (tCO_2)
EC_y	Electricity consumption by project equipment during the year *y* (MWh)
$EF_{grid,CO2,y}$	Carbon dioxide emission factor for grid electricity consumed by project equipment in the year *y* (tCO_2e/MWh)

The emissions from flaring are determined according to the procedures described in the "*Tool to determine project emissions from flaring gases containing methane*" and specifically for each flare installed due to the project activity:

$$PE_{flare,y} = \sum_{h=1}^{8,760} TM_{RG,h} \cdot (1 - \eta_{flare,h}) \cdot \frac{GWP_{CH4}}{1,000}$$

Where:

$TM_{RG,h}$	Mass flow rate of methane in the residual gas stream in year *y*
$\eta_{flare,h}$	Flare efficiency in hour *h*
GWP_{CH4}	Global Warming Potential of methane (valid for the commitment period)

The following stepwise approach is taken to determine the project emission from flaring while the methodological choices differ according to either *ex-ante* estimation of this emission source or *ex-post* calculation.

Tool- STEP 1. Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour *h*, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h}$$

Where:

$FM_{RG,h}$	Mass flow rate of the residual gas in hour *h* (kg/h)
$\rho_{RG,n,h}$	Density of the residual gas at normal conditions in hour *h* (kg/m^3)
$FV_{RG,h}$	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h* (m^3/h)

and:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} * T_n}$$

Where:

P_n	P_n Pa Atmospheric pressure at normal conditions (Pa)
R_u	Universal ideal gas constant (Pa.m^3/kmol.K)
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
T_n	Temperature at normal conditions (K)

and:

$$MM_{RG,h} = \sum \left(fv_{i,h} * MM_i \right)$$

Where:

$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
$fv_{i,h}$	Volumetric fraction of component i in the residual gas in the hour *h* (ratio)
MM_i	Molecular mass of residual gas component *i* (kg/kmol)
i	Components CH_4, CO, CO_2, O_2, H_2, N_2

As a simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

Tool- STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

The mass fraction of carbon, hydrogen, oxygen and nitrogen of the residual gas ($fm_{j,h}$) can be calculated as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} * AM_j * NA_{j,i}}{MM_{RG,h}}$$

Where:

$fm_{j,h}$	Mass fraction of element j in the residual gas in hour *h* (ratio)
$fv_{i,h}$	Volumetric fraction of component i in the residual gas in the hour *h* (ratio)
AM_j	Atomic mass of element *j* (kg/kmol)
$NA_{j,i}$	Number of atoms of element j in component *i*
$MM_{RG,h}$	Molecular mass of the residual gas in hour *h* (kg/kmol)
j	Elements carbon, hydrogen, oxygen and nitrogen

Tool- STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

Ex-post calculation: This step is only applicable if the methane combustion efficiency of the flare is continuously monitored. This option is chosen by the project participant(s).

Ex-ante estimation: For the purpose of the *ex-ante* estimate of the project emissions from flaring, the default value efficiency for the flaring efficiency is chosen. In this case, this step is neglected.

Determine the average volumetric flow rate of the exhaust gas in each hour h based on a stochiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{nFG,h} = V_{n,FG,h} \times FM_{RG,h}$$

Where:

$TV_{n,FG,h}$	Volumetric flow rate of exhaust gas in dry basis at normal conditions in the hour *h* (m^3/h)
$V_{n,FG,h}$	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h* (m3/kg)
$FM_{RG,h}$	Mass flow rate of the residual gas in the hour *h* (kg/h)

$$V_{nFG,h} = V_{a,CO_2,h} + V_{n,o_2,h} + V_{n,N_2,h}$$

Where:

$V_{n,FG,h}$	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h* (m^3/kg)
$V_{n,CO2,h}$	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)
$V_{n,N2,h}$	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)
$V_{n,O2,h}$	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)

$$V_{n,O2,h} = n_{O2,h} * MV_n$$

Where:

$V_{n,O2,h}$ Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)

$N_{O2,h}$ Quantity of moles of O_2 in the exhaust gas of the flare per kg of residual gas flared in hour *h* (m^3/kg)

MV_n Volume of one mole of any ideal gas at normal temperature and pressure (m^3/kmol)

$$V_{n,N2,h} = MVn * \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) * [F_{h+nO2,h}] \right\}$$

Where:

$V_{n,N2,h}$ Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)

MV_n Volume of one mole of any ideal gas at normal temperature and pressure (m^3/kmol)

$fm_{N,h}$ Mass fraction of nitrogen in the residual gas in the hour *h* (ratio)

AMn Atomic mass of nitrogen (kg/mol)

MF_{O2} O_2 volumetric fraction of air (ratio)

F_h Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (m^3/kg)

$n_{O2,h}$ Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (m^3/kg)

$$V_{nCO2,h} = \frac{fm_{C,h}}{AM_c} * MV$$

Where:

$V_{n,CO2,h}$ Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m^3/kg)

MV_n Volume of one mole of any ideal gas at normal temperature and pressure (m^3/kmol)

$fm_{C,h}$ Mass fraction of carbon in the residual gas in the hour *h* (ratio)

AM_C Atomic mass of carbon (kg/mol)

$$n_{O2,h} = \frac{t_{O2,h}}{\left(1 - \left(t_{O2} / MF_{O2}\right)\right)} * \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) * F_h \right]$$

Where:

$n_{O2,h}$ Quantity of moles of O_2 in the exhaust gas of the flare of residual gas flared in hour *h* (kmol/kg)

$t_{O2,h}$ Volumetric fraction of O_2 in the exhaust gas in the hour *h* (ratio)

MF_{O2} Volumetric fraction of O_2 in the air (ratio)

Fh Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg of

	residual gas in hour *h* (kmol/kg)
$fm_{j,h}$	Mass fraction of element j in the residual gas in hour *h* (ratio)
AM_j	Atomic mass of element *j* (kg/kmol)
j	The elements carbon (index C) and nitrogen (index N)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O}$$

Tool- STEP 4. Determination of methane mass flow rate in the exhaust gas on a dry basis
Ex-post calculation: This step is only applicable if the methane combustion efficiency of the flare is continuously monitored. This option is chosen by the project participant(s).
Ex-ante estimation: For the purpose of the *ex-ante* estimate of the project emissions from flaring, the default value efficiency for the flaring efficiency is chosen. In this case, this step is neglected.

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} \times fv_{CH4,FG,h}}{1000000}$$

Where

$TM_{FG,h}$	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h* (kg/h)
$TV_{n,FG,h}$	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (m^3/h)
$fv_{CH4,FG,h}$	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h* (mg/m^3)

Tool- STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis
The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60ºC), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis).

$TM_{RG,h} = FV_{RG,h} \text{ x } fv_{CH4,RG,h} \text{ x } \rho_{CH4,n}$

Where:

$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal

		conditions in hour *h* (m^3/h)
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where *i* refers to methane) (ratio)
$\rho_{CH4,n}$	kg/m^3	Density of methane at normal conditions (kg/m^3)

Tool- STEP 6. Determination of the hourly flare efficiency

Ex-post calculation: The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature) and the type of flare used (open or enclosed). In the project activity an enclosed flare will be installed. Therefore, the flare efficiency in hour *h* is:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour *h*.
- Determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes:

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

Where:

$\eta_{flare,h}$	Flare efficiency in the hour *h* (ratio)
$TM_{FG,h}$	Methane mass flow rate in exhaust gas averaged in a hour h (kg/h)
$TM_{RG,h}$	Mass flow rate of methane in the residual gas in the hour *h* (kg/h)

The destruction efficiency for landfill gas combusted for energy is assumed as 100%. This is in line with paragraph 12 of AMS-III.G.

Ex-ante estimation: The flare efficiency in the hour *h* is assumed as:

- 90% as the temperature in the exhaust gas of the flare is assumed to be above 500 °C for more than 40 minutes during the hour *h* in any hour of the year *y*.

The destruction efficiency for landfill gas combusted for energy is assumed as 100%. This is in line with paragraph 12 of AMS-III.G.

Tool- STEP 7. Calculation of annual project emissions from flaring

The emissions will be determined according to the above mentioned formula (before Tool-Step 1).

{In case LFG is also utilized and CERs claimed for this activity: PROJECT EMISSIONS OF COMPONENT 2}

{In case LFG utilization is for direct power generation, else delete:

According to § 19 of AMS-I.F, for renewable energy project activities other than geothermal power plants and hydropower plants covered by the methodology, project emissions have only to be considered for the consumption of fossil fuels due to the project activity. For the proposed PoA consumption of fossil fuels due to the project activity (e.g. for transportation of biomass) are not relevant since only LFG is utilized and transport based on fossil fuel consumption thus spares. Therefore:

PE_y = 0 tCO_2e
}

{In case LFG utilization is for direct heat/steam generation, else delete:
According to § 45 of AMS-I.C project emissions include:

i. CO_2-emissions from on-site consumption of fossil fuels due to the project activity;
ii. CO_2-emissions from electricity consumption by the project activity; and
iii. Any other significant emissions associated with the project activity and within the project boundary.

Ad i.): The operation of the heat generation equipment under the proposed PoA will not be linked to the on-site consumption of fossil fuels. This source of project emissions can thus be neglected.

Ad ii.): {If applicable calculate emissions accordingly, else mention that this source is irrelevant} The operation of heat generation equipment under the proposed PoA is linked to the operation of auxiliary electronic equipment. Project emissions from this source will be calculated as per the procedures detailed in latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption":

$$PE_y = EC_y \cdot EF_{grid,CO2,y}$$

Where:

PE_y	Project emissions during the year *y* (tCO_2)
EC_y	Electricity consumption by project equipment during the year *y* (MWh)
$EF_{grid,CO2,y}$	Carbon dioxide emission factor for grid electricity consumed by project equipment in the year *y* (tCO_2e/MWh)

Ad iii.): Other significant emissions associated with the project activity and within the project boundary are not expected. This PE-source is thus disregarded.
}

{In case LFG utilization is for direct heat/steam and power generation, else delete:
According to § 45 of AMS-I.C project emissions include:

i. CO_2-emissions from on-site consumption of fossil fuels due to the project activity;
ii. CO_2-emissions from electricity consumption by the project activity; and
iii. Any other significant emissions associated with the project activity and within the project boundary.

Ad i.): {If applicable calculate emissions accordingly, else mention that this source is irrelevant: The operation of the renewable energy generation equipment under the proposed PoA is not linked to the consumption of fossil fuels. This PE-source can thus be disregarded.}

Ad ii.): {If applicable calculate emissions accordingly, else mention that this source is irrelevant: The operation of renewable energy generation equipment under the proposed PoA is linked to the operation of auxiliary electronic equipment. The electricity consumption by this equipment will not be monitored as only net electricity generation is accounted for under the baseline ($EG_{BL,y}$ or $EG_{captelec,PJ,y}$). This source is thus set to zero. }

Ad iii.): Other significant emissions associated with the project activity and within the project boundary Other significant emissions associated with the project activity and within the project boundary are not assumed. This source is thus considered irrelevant.
}

LEAKAGE EMISSIONS

Equipment will not be transferred from another activity. Thus leakage emissions from this source are zero:

LE_y = 0 tCO_2e

{Only if LFG is utilized and CERs are claimed for this activity, else delete: Attachment C to Appendix B for the calculation of leakage emissions in biomass projects is not relevant as the renewable fuel consumed in the PoA will be LFG. LFG can be considered a biomass residue. This source of leakage is thus not applicable. }

EMISSION REDUCTION

{Only if LFG is utilized and CERs are claimed for this activity, else delete: **Step 1**: Emission reductions from “methane avoidance” }

The actual emission reductions from “methane avoidance” will be estimated *ex-ante* as follows:

$$ER_{y,estimated} = BE_{y,ex-ante} - PE_y - LE_y$$

In order to account for the fact that not all landfill gas generating on the landfill according to the FOD-model applied in the determination of $BE_{CH4,SWDS,y}$ will be actually captured by the capture system the parameter R_r is introduced. It represents the recovery rate for landfill gas. Landfill gas not recovered continues to emit to the atmosphere (e.g. through the surface of the landfill). Therefore, BE_y is redefined for the *ex-ante* calculation as follows:

$$BE_{y,ex-ante} = BE_{CH4,SWDS,y} \cdot R_r - MD_{reg,y} \cdot GWP_{CH4}$$

Where:

R_r Recovery rate of the landfill gas, i.e. ratio of landfill gas/methane captured (ratio)

R_r: The recovery rate R_r is usually up to 50%. For the issuance of CERs this parameter is irrelevant as it is not applied in the *ex-post* calculation of CERs.

For the *ex-post* calculation monitored values will be used and the calculation will be done according to the following formula:

$$ER_{y,calculated} = \left(MD_y - MD_{reg,y}\right) \cdot GWP_{CH4} - PE_y - LE_y$$

Where:

MD_y	Methane captured and destroyed/gainfully used by the project activity in the year *y* (tCO_2e)
PE_y	Project emissions common to all scenarios (i.e. according to AMS-III.G) (tCO_2e)
LE_y	Leakage emissions common to all scenarios (i.e. according to AMS-III.G) (tCO_2e)

MD_y (the methane captured and destroyed or gainfully used) shall be measured and parameters applied in the following formula:

$$MD_y = D_{CH4,y} \cdot \omega_{CH4,y} \cdot \sum_i LFG_{i,y}$$

Where:

$LFG_{i,y}$	Landfill gas destroyed via method *i* (e.g. flaring or fuelling) in the year *y* (m^3).
$\omega_{CH4,y}$	Methane content in landfill gas in the year *y* (m^3 CH_4/m^3 LFG).
$D_{CH4,y}$	Density of methane at the temperature and pressure of the landfill gas (tonnes/m^3).

{In case LFG is utilized and CERs claimed for this activity: **Step 2:** Baseline emissions, project emissions, and leakage emissions from component 2 are added as follows:

$$ER_{y,scen2} = BE_{y,scen2} - PE_{y,scen2} - LE_{y,scen2}$$

$ER_{y,scen2}$	Emission reduction from LFG utilization under scenario 2 during the year *y* (tCO_2)
$BE_{y,scen2}$	Baseline emissions under scenario 2 during the year *y* (tCO_2)
$PE_{y,scen2}$	Project emissions under scenario 2 during the year *y* (tCO_2)
$LE_{y,scen2}$	Leakage emissions under scenario 2 during the year *y* (tCO_2)

Total emission reductions (ER_y) can be calculated *ex-post* as follows:

$$ER_y = ER_{y,calculated} - ER_{y,scen2}$$

Total emission reductions (ER_y) can be calculated *ex-ante* as follows:

$$ER_y = ER_{y,estimated} - ER_{y,scen2}$$

}

B.5.1. Data and parameters that are available at validation:

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Value applied:	[xx]
Source of data used:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Determined once at inclusion of CPA into PoA
Any comment:	

Data / Parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Value applied:	[xx]
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Justification of the choice of data or description of measurement methods and procedures actually applied :	Determined once at inclusion of CPA to PoA
Any comment:	

Data / Parameter:	**DOC_j**
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type j
Value applied:	[xx]
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from

	Volume 5, Tables 2.4 and 2.5)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Determined once at inclusion of CPA to PoA
Any comment:	

Data / Parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type j
Value applied:	[xx]
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Determined once at the inclusion of the CPA into the PoA
Any comment:	

Data / Parameter:	**Wj,x**
Data unit:	tons
Description:	Amount of waste type *j* deposited in year *x*
Value applied:	[xx]
Source of data used:	Sampling
Justification of the choice of data or description of measurement methods and procedures actually applied :	{In case of closed landfills} Waste composition was determined through sampling {In case of open landfills} Waste composition was determined through sampling. Sampling will be continued for open landfill compartments determining parameters W_x, $p_{n,j,x}$ and z.
Any comment:	

Data / Parameter:	**Rr**
Data unit:	Ratio
Description:	Recovery rate of the project's landfill gas capture system
Value applied:	[xx]
Source of data used:	Own estimation by project participants.
Justification of the choice of data or description of measurement methods	A value of up to 0.5 is regarded reasonable. Determined once at inclusion of CPA into PoA.

and procedures actually applied :	
Any comment:	Only applied for the *ex-ante* estimation of emission reductions.

{In case LFG utilization is included in boundary and LFG is utilized for direct electricity generation or direct heat and electricity generation}

Data / Parameter:	$EG_{n,y}$
Data unit:	MWh
Description:	Quantity of electricity generated in captive power plant in year *y*
Value applied:	[1 year ago: xx] [2 years ago: xx] [3 years ago: xx]
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Electricity meter
QA/QC procedures to be applied:	In case of existing plants data from the most recent three years shall be taken.
Any comment:	

{In case LFG utilization is included in boundary and LFG is utilized for direct electricity generation or direct heat and electricity generation}

Data / Parameter:	$FC_{n,i,y}$
Data unit:	(mass or volume unit)
Description:	Quantity of fossil fuel type *i* fired in the captive power plant *n* during the year *y*
Value applied:	[1 year ago: xx] [2 years ago: xx] [3 years ago: xx]
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Flow meters in case of volumetric data. Weighs in case of mass data.
QA/QC procedures to be applied:	In case of existing plants data from the most recent three years shall be taken.
Any comment:	

{In case LFG utilization is included in boundary and LFG is utilized for direct electricity generation or direct heat and electricity generation}

Data / Parameter:	$NCV_{i,y}$
Data unit:	GJ/mass or volume unit
Description:	Quantity of fossil fuel type *i* fired in the captive power plant *n* during the year *y*

Value applied:	[1 year ago: xx] [2 years ago: xx] [3 years ago: xx]
Source of data used:	Default values at the upper limit of the uncertainty range at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 of the latest version of the IPCC Guidelines on National Greenhouse Gas Inventories
Description of measurement methods and procedures to be applied:	n/a
QA/QC procedures to be applied:	In case of existing plants data from the most recent three years shall be taken.
Any comment:	

{In case LFG utilization is included in boundary and LFG is utilized for direct electricity generation or direct heat and electricity generation}

Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO2/GJ
Description:	CO2 emission factor of fuel type *i* used during the year *y*
Value applied:	[1 year ago: xx] [2 years ago: xx] [3 years ago: xx]
Source of data used:	Default values at the upper limit of the uncertainty range at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Volume 2 of the latest version of the IPCC Guidelines on National Greenhouse Gas Inventories
Description of measurement methods and procedures to be applied:	n/a
QA/QC procedures to be applied:	In case of existing plants data from the most recent three years shall be taken.
Any comment:	

{In case LFG utilization is included in boundary and LFG is utilized for direct heat generation or direct heat and electricity generation}

Data / Parameter:	**$EF_{FF,CO2}$** (scenario 2b or 2c), **$EF_{BL,FF,CO2}$** (scenario 2c)
Data unit:	tCO2/TJ
Description:	CO2 emission factor of the fossil fuel that would have been used in the baseline
Value applied:	
Source of data used:	Default values at the upper limit of the uncertainty range at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Volume 2 of the latest version of the IPCC Guidelines on National Greenhouse Gas Inventories
Description of measurement methods	n/a

and procedures to be applied:	
QA/QC procedures to be applied:	
Any comment:	Relevant, if thermal energy generation by the project activity displaces fossil fuel based thermal energy generation.

{In case LFG utilization is included in boundary}

Data / Parameter:	$\eta_{BL,thermal}$, $\eta_{BL,captive\ plant}$, $\eta_{BL,cogen}$
Data unit:	Ratio
Description:	(Thermal or electrical) energy generation efficiency of the plant that would have been used in the baseline
Value applied:	
Source of data used:	See below: according to options a, b, or c
Description of measurement methods and procedures to be applied:	The baseline efficiency shall be calculated based on the average efficiency of heat/steam generation during the most recent years (up to three years). If such historic data is not available a performance test/measurement campaign shall be done before the project implementation.
QA/QC procedures to be applied:	
Any comment:	In case of energy generation by the project activity displacing fossil fuel based baseline energy generation (scenario 2a, 2b, or 2c).

B.5.2. Ex-ante calculation of emission reductions:

In the following *ex-ante* calculation of emission reductions values from the first (complete) year of project operation have been inserted to applicable formulae.

BASELINE EMISSIONS {In case LFG is also utilized and CERs claimed for this activity: OF COMPONENT 1 }

Due to the complexity of the FOD-model applied by the "Tool to determine methane emissions avoided from the disposal of waste at a solid waste disposal sites", the *ex-ante* calculation can be retraced in the attached MS-excel file.

$$BE_y = BE_{CH4,SWDS,y} - MD_{reg,y} \cdot GWP_{CH4}$$

Where:

$$MD_{reg,y} = 0\ tCH_4$$

And:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot (1-e^{-k_j})$$

$BE_{CH4,SWDS,y}$ = [xx]· (1 - 0.[x])·21 tCO_2e/tCH_4 ·(1 - 0.[x])·16/12·0.5·0.5·[xx]·

$$\sum_{x=1}^{y}\sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot (1-e^{-k_j})$$

= [xxx] tCO_2e

Thus:

BE_y = [xxxx] tCO_2e – 0 tCO_2e
= [xxxx] tCO_2e

{The section "Baseline emissions of Component 2" is only for the case of any of scenarios 2 is relevant to the CPA; else delete}

BASELINE EMISSIONS OF COMPONENT 2

{Following sub-section only in case LFG will be utilized for direct electricity generation (in electricity-only mode and CERs claimed for this activity; no co-generation:

From the utilization of [x % or x m^3] of LFG, the following quantities of baseline emissions related to (partially) fossil fuel based electricity generation are calculated:

BE_y = $EG_{BL,y} \cdot EF_{CO2,grid,y}$
= [xx] MWh·[xx] tCO_2e/MWh
= [xx] tCO_2e

The gas utilization starts in the [x]-th year of the project activity and end in the [x]-th year of the project activity, i.e. gas utilization is from 20[xx] to 20[xx].

}

{In case all electricity displaced is from (a) captive power plant(s):

The emissions factor for the baseline captive power generation is calculated based on the historic data from the most recent [value smaller or equal to three] years as follows:

$EF_{CO2,grid,y}$ = $(FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) \div EG_{n,y}$
= ([xx t OR xx m^3]·[xx] GJ/[t OR m^3]·[xx] tCO_2e/GJ)÷[xx] MWh
= [xx] tCO_2e/MWh

}

{In case electricity from both captive power plants and grid is displaced; project activity is not greenfield:

The emissions factor is calculated based as weighted average of the average emission factor of captive generation based on historic data and of the grid emission factor.

For the *ex-ante* calculation of the weighted average emission factor the following generation shares were assumed:

Year	Project Generation (EG)	Share of Grid in BL	Share of Captive Power in BL
all years	[xx] GWh	[yy]%	[zz]%

{Add up to another two years if different values in each year}

The captive power emission factor is:

$$EF_{CO2,captive,y} = (FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) \div EG_{n,y}$$
$$= ([xx\ t\ OR\ xx\ m^3] \cdot [xx]\ GJ/[t\ OR\ m^3] \cdot [xx]\ tCO_2e/GJ) \div [xx]\ MWh$$
$$= [xx]\ tCO_2e/MWh$$

The grid emission factor is:

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}

The weighted average emission factor is thus:

$EF_{CO2,grid,y}$ = [yy]%·0.2849 tCO_2e/MWh {update as applicable} + [zz]%·[ss] tCO_2e/MWh
= [xx] tCO_2e/MWh

}

{In case electricity from both captive power plants and grid is displaced; project activity is greenfield:

The emission factor is calculated as the lower of the two emission factors for grid electricity and for electricity generated in (a) captive power plant(s).

The captive power emission factor is:

$$EF_{CO2,captive,y} = (FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) \div EG_{n,y}$$
$$= ([xx\ t\ OR\ xx\ m^3] \cdot [xx]\ GJ/[t\ OR\ m^3] \cdot [xx]\ tCO_2e/GJ) \div [xx]\ MWh$$
$$= [xx]\ tCO_2e/MWh$$

The grid emission factor is:

$EF_{CO2,grid,y}$ = 0.2849 tCO_2e/MWh {update as applicable}

The emission factor is thus:

$EF_{CO2,grid,y}$ = MIN(0.2849 tCO_2e/MWh {update as applicable}, [xx] tCO_2e/MWh)
= [xx] tCO_2e/MWh

}

{Following sub-section only in case LFG will be utilized for direct heat generation (in heat-only mode; no co-generation) and CERs claimed for this activity:

The emission reduction due to the fossil fuel based steam/heat production is calculated as follows:

$$BE_{thermal,CO2,y} = (EG_{thermal,y} \div \eta_{BL,thermal}) \cdot EF_{FF,CO2}$$
$$= ([xx]\ TJ \div [xx]) \cdot [xx]\ tCO_2e/TJ$$
$$= [xx]\ tCO_2e$$

{For heat only and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:

The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity. In terms of the proposed activity the lower of the two is [EITHER (a) OR (b)]. }
}

{Following sub-section only in case LFG will be utilized for direct heat and power generation (co-generation) and CERs claimed for this activity:
{If baseline scenario is fossil fuel based generation of electricity in a captive power plant:

$$\begin{aligned} BE_{captelec,y} &= (EG_{captelec,PJ,y} \div \eta_{BL,captiveplant}) \cdot EF_{BL,FF,CO2} \\ &= ([xx]\ MWh \div [xx]) \cdot [xx]\ tCO_2e/MWh \\ &= [xx]\ tCO_2e \end{aligned}$$

The emission factor for captive electricity generation is calculated as:

$$\begin{aligned} EF_{BL,FF,CO2} &= (FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) \div EG_{n,y} \\ &= ([xx\ t\ OR\ xx\ m^3] \cdot [xx]\ GJ/[t\ OR\ m^3] \cdot [xx]\ tCO_2e/GJ) \div [xx]\ MWh \\ &= [xx]\ tCO_2e/MWh \end{aligned}$$

}

{For captive, fossil fuel based power generation and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{BL,FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity. }

{If baseline scenario is grid import and/or export of electricity:

$$\begin{aligned} BE_y &= EG_{BL,y} \cdot EF_{BL,FF,CO2} \\ &= [xx]\ MWh \cdot 0.2849\ tCO_2e/MWh\ \{update\ as\ applicable\} \\ &= [xx]\ tCO_2e \} \end{aligned}$$

{If the baseline is captive electricity generation and/or displacement of grid electricity import and/or supply of electricity to a grid and existing plants are displaced:

$$BE_y = EG_{BL,y} \cdot EF_{BL,FF,CO2}$$

The emission factor ($EF_{BL,FF,CO2}$) reflects both the emission intensity of the captive power plant and the grid. The annual electricity production in the project activity ($EG_{BL,y}$) was compared to:

- On-site captive electricity generation;
- Electricity import minus the electricity export.

If the baseline electricity is smaller than or equals the electricity generated by the project activity, then the emission factor is calculated as the weighted average of on-site captive electricity generation and the net grid electricity import in the baseline.

If the baseline electricity is greater than the electricity generated by the project activity, then the lower of the two emission factors is used for the incremental generation.
}

{If the baseline is captive electricity generation and/or displacement of grid electricity import and/or supply of electricity to a grid and there are no existing plants that are displaced:

$BE_y = EG_{BL,y} \cdot EF_{BL,FF,CO2}$

As the project plant is a new plant, the emission factor reflects the lower of the emission intensity of the baseline captive power plant and the grid. The emission factor for the captive electricity generation is calculated as:

$$EF_{captive} = (FC_{n,i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) \div EG_{n,y}$$
$$= ([xx\ t\ OR\ xx\ m^3] \cdot [xx]\ GJ/[t\ OR\ m^3] \cdot [xx]\ tCO_2e/GJ) \div [xx]\ MWh$$
$$= [xx]\ tCO_2e/MWh$$

The emission factor of the grid is:

$EF_{grid} = 0.2849\ tCO_2e/MWh$ {update as applicable}

The emission factor is thus:

$EF_{BL,FF,CO2} = MIN(0.2849\ tCO_2e/MWh$ {update as applicable}, $[xx]\ tCO_2e/MWh)$
$= [xx]\ tCO_2e/MWh$
}

{If baseline scenario is fossil fuel based generation of heat/steam:
The emission reduction due to the fossil fuel based steam/heat production is calculated as follows:

$$BE_{thermal,CO2,y} = (EG_{thermal,y} \div \eta_{BL,thermal}) \cdot EF_{FF,CO2}$$
$$= ([xx]\ TJ \div [xx]) \cdot [xx]\ tCO_2e/TJ$$
$$= [xx]\ tCO_2e$$
}

{For fossil fuel based generation of heat/steam and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity.
}

{If baseline scenario is the fossil fuel based co-generation of power and heat/steam (co-generation); Remark: Greenfield activities were excluded for this activity:
This baseline corresponds to baseline scenario (D) described in AMS-I.C. The following formula has been used to determine baseline emissions:

$BE_{cogen,CO2,y}$ = $[(EG_{PJ,thermal,y}+EG_{PJ,electrical,y} \cdot 3.6) \div \eta_{BL,cogen}] \cdot EF_{FF,CO2}$
= [([xx] TJ+[xx] GWh·3.6)÷[xx]]· [xx] tCO_2e/TJ
= [([xx] TJ)÷[xx]] · [xx] tCO_2e/TJ
= [xx] tCO_2e
}

{For fossil fuel based co-generation in the baseline and if the project activity is implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, else delete:
The emission factor $EF_{FF,CO2}$ is chosen as lower of the two (a) the emission factor of the fossil fuel that would have been used in the identified baseline scenario, and (b) the emission factor of the fossil fuel that was used prior to the implementation of the project activity.}

PROJECT EMISSIONS {In case LFG is also utilized and CERs claimed for this activity: OF COMPONENT 1 }

Project emissions comprise of CO_2-emissions related to the power or electricity consumption by the project activity facilities and emissions from flaring or combustion of the gas stream and they calculate as:

$$PE_y = PE_{power,y} + PE_{flare,y}$$

With:

$$PE_{power,y} = EC_y \cdot EF_{grid,CO2,y}$$

and:

$$PE_{flare,y} = \sum_{h=1}^{8,760} TM_{RG,h} \cdot (1 - \eta_{flare,h}) \cdot \frac{GWP_{CH4}}{1,000}$$

The power consumption of the facilities installed to capture and flare landfill gas will be monitored during the project activity and project emissions are estimated as follows:

PE_y = $EC_y \cdot EF_{grid,CO2,y}$
= [xx] MWh·[xx] tCO_2e/MWh
= [xx] tCO_2e

{In case LFG is also utilized and CERs claimed for this activity: The power consumption by facilities other than for the capture and flaring of landfill gas are accounted for below. }

The emissions from flaring take into account that some gas might be destroyed by combustion for energy and not by flaring. However, as the destruction efficiency is assumed to be 100% in case of destruction by combustion for energy (in line with AMS-III.G, paragraph 12), the part of landfill gas that is utilized for this purpose is irrelevant to determine project emissions from flaring.

For the ex-ante estimation it is assumed gas was flared at the same conditions during all 8,760 hours of a year. The flaring efficiency is assumed as the default value provided for by the Tool for properly operated enclosed flares. A CPA always installs an enclosed flare. This ends up in the following calculation:

$$PE_{flare,y} = [\, TM_{RG,h} \cdot (1 - \eta_{flare,h}) \cdot GWP_{CH4} \div 1{,}000 \,] \cdot 8{,}760 \text{ h}$$
$$= [\, [xx] \text{ kg/h} \cdot (1 - 0.9) \cdot 21 \text{ tCO2e/tCH4} \div 1{,}000] \cdot 8{,}760 \text{ h}$$
$$= [xx] \text{ tCO}_2\text{e}$$

Whereby the “mass flow rate of methane in the residual gas in the hour h ($TM_{RG,h}$) was calculated as follows:

$$TM_{RG,h} = FV_{RG,h} \cdot fv_{CH4,RG,h} \cdot \rho_{CH4,n}$$
$$= [xx] \text{ m}^3\text{/h} \cdot 50\% \cdot 0.7156 \text{ kg/m}^3$$
$$= [xx] \text{ kg/h}$$

For the *ex-ante* calculation, the “volumetric fraction of methane in the residual gas on dry basis at normal conditions in hour h” is assumed to be equal to the parameter “F”, i.e. the fraction of methane in landfill gas according to the “Tool to determine methane emissions avoided from the disposal of waste at a solid waste disposal site”.

<u>{In case LFG is also utilized and CERs claimed for this activity: PROJECT EMISSIONS OF COMPONENT 2}</u>

{In case LFG utilization is for direct power generation, else delete:
In the proposed activity, the consumption of fossil fuels due to the project activity is irrelevant since only LFG is utilized and transport based on fossil fuel consumption thus spares. Therefore:

$$PE_y = 0 \text{ tCO}_2\text{e}$$
}

{In case LFG utilization is for direct heat/steam generation, else delete:
The only relevant source of project emissions is from electricity consumption due to the project activity. Project emissions from this source were calculated as:

$$PE_y = EC_y \cdot EF_{grid,CO2,y}$$
$$= [xx] \text{ MWh} \cdot [xx] \text{ tCO}_2\text{e/MWh}$$
$$= [xx] \text{ tCO}_2\text{e}$$
}

{In case LFG utilization is for direct heat/steam and power generation, else delete:
There are no further relevant sources of project emissions. Thus:

PE_y = 0 tCO_2e
}

LEAKAGE EMISSIONS

LE_y = [xx] tCO_2e

EMISSION REDUCTION

The actual emission reductions from “methane avoidance” were calculated *ex-ante* with the following formula:

$ER_{y,estimated}$ = $BE_{y,ex\text{-}ante} - PE_y - LE_y$

$BE_{y,ex\text{-}ante}$ = $BE_{CH4,SWDS,y} \cdot R_r - MD_{reg,y} \cdot GWP_{CH4}$
= [xx] $tCO_2e \cdot 50\% - 0\ tCH_4 \cdot 21\ tCO_2e/tCH_4$
= [xx] tCO_2e

and:

$ER_{y,estimated}$ = $BE_{y,ex\text{-}ante} - PE_y - LE_y$
= [xx] tCO_2e – [xx] tCO_2e – [xx] tCO_2e
= [xx] tCO_2e

{In case LFG is utilized and CERs claimed for this activity: The actual emission reductions from “energy recovery from LFG” were calculated as follows:

$ER_{y,scen2}$ = $BE_{y,scen2} - PE_{y,scen2} - LE_{y,scen2}$
= [xx] tCO_2e + [xx] tCO_2e + [xx] tCO_2e
= [xxxx] tCO_2e

Total emission reductions (ER_y) can be calculated as follows:

$ER_{y,total}$ = $ER_{y,estimated} - ER_{y,scen2}$
= [xx] tCO_2e + [xx] tCO_2e
= [xxxx] tCO_2e
}

B.5.3. Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions	Estimation of baseline emissions	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions

	(tonnes of CO_2e)	**(tonnes of CO_2e)**		**(tonnes of CO_2e)**
Year 1	[xx]	[xx]	[xx]	[xx]
Year 2	[xx]	[xx]	[xx]	[xx]
Year 3	[xx]	[xx]	[xx]	[xx]
Year 4	[xx]	[xx]	[xx]	[xx]
Year 5	[xx]	[xx]	[xx]	[xx]
Year 6	[xx]	[xx]	[xx]	[xx]
Year 7	[xx]	[xx]	[xx]	[xx]
Year 8	[xx]	[xx]	[xx]	[xx]
Year 9	[xx]	[xx]	[xx]	[xx]
Year 10	[xx]	[xx]	[xx]	[xx]
Total (tonnes of CO_2e)	[xx]	[xx]	[xx]	[xx]

B.6. Application of the monitoring methodology and description of the monitoring plan:

B.6.1. Description of the monitoring plan:

The monitoring of the SSC CPA is by the CME. Due to the attribution of monitoring obligations to the CME, the monitoring plan has been described already in the PoA-DD uniformly for all CPAs. Please refer to the relevant sections of the PoA-DD.

The following parameters will be monitored:

Data / Parameter:	**$LFG_{i,y}$**
Data unit:	Nm^3
Description:	Total amount of landfill gas (at normal conditions) destroyed via method *i* in year *y*
Source of data used:	Continuous flow meter with automated volume recording
Description of measurement methods and procedures to be applied:	The methane content measurement shall be carried out close to a location in the system where a landfill gas flow measurement takes place.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Daily recording.
Any comment:	No separate monitoring of temperature and pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.

Data / Parameter:	**$\omega_{CH4,y}$**
Data unit:	% (m^3CH_4/m^3LFG)
Description:	Methane content in the LFG in the year *y*

Source of data used:	Gas analyzer measuring methane content directly
Description of measurement methods and procedures to be applied:	The measurement shall be carried out close to where the flow measurement takes place and at the same basis (wet or dry).
QA/QC procedures to be applied:	The analyzer will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Recording at the same frequency as for the flow values.
Any comment:	

Data / Parameter:	**T**
Data unit:	°C
Description:	Temperature of the landfill gas to normalize the volume of landfill gas destroyed
Source of data used:	Temperature sensor in gas flow
Description of measurement methods and procedures to be applied:	If the landfill gas flow meter measures flow, pressure, and temperature and displays or outputs normalised flow of landfill gas, then there is no need for separate monitoring of this parameter.
QA/QC procedures to be applied:	The sensor will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Shall be measured at the same time when methane content in the landfill gas is measured.
Any comment:	

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of landfill gas to normalize the volume of landfill gas destroyed
Source of data used:	Pressure sensor in gas flow
Description of measurement methods and procedures to be applied:	Shall be measured at the same time when methane content in the landfill gas is measured. If the landfill gas flow meter measures flow, pressure, and temperature and displays or outputs normalised flow of landfill gas, then there is no need for separate monitoring of this parameter.
QA/QC procedures to be applied:	The sensor will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous.
Any comment:	

Data / Parameter:	$\mathbf{fv_{i,h}}$
Data unit:	Ratio
Description:	Volumetric fraction of component *i* in the residual gas in hour *h* (i= CH_4, CO, CO_2, O_2, H_2 and N_2)
Source of data used:	Gas analyser
Description of	Ensure that the same basis (dry basis) is considered here and for $FV_{RG,h}$

measurement methods and procedures to be applied:	
QA/QC procedures to be applied:	The gas analyzer will be subject to a regular maintenance according to manufacturer's indications. A zero check and a typical value check should be performed by comparison with standard certified gas. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Values to be averaged hourly. Monthly recording.
Any comment:	As a simplified approach, only CH_4-content might be measured while considering the remaining part as N_2.

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*
Source of data used:	Flow meter
Description of measurement methods and procedures to be applied:	Ensure that the same basis (dry or wet) is considered here and for $fv_{i,h}$
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Values to be averaged hourly. Monthly recording.
Any comment:	This parameter represents a fraction of $LFG_{burnt,y}$.

Data / Parameter:	**$t_{02,h}$**
Data unit:	Ratio
Description:	Volumetric fraction of O2 in the exhaust gas of the flare in hour *h*
Source of data used:	Gas analyzer
Description of measurement methods and procedures to be applied:	Extractive sampling analysers with water and particulates removal devices or in-situ analyzers for wet basis determination. The point of measurement shall be in the upper section of the flare (80% of total flare length). Sampling shall be conducted with appropriate probes adequate to high temperatures.
QA/QC procedures to be applied:	The gas analyzer will be subject to a regular maintenance according to manufacturer's indications. A zero check and a typical value check should be performed by comparison with standard certified gas. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Values to be averaged hourly. Monthly recording.
Any comment:	

Data / Parameter:	**$fv_{CH4,FG,h}$**
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h*
Source of data used:	Gas analyzer

Description of measurement methods and procedures to be applied:	Extractive sampling analysers with water and particulates removal devices or in-situ analyzers for wet basis determination. The point of measurement shall be in the upper section of the flare (80% of total flare length). Sampling shall be conducted with appropriate probes adequate to high temperatures.
QA/QC procedures to be applied:	The gas analyzer will be subject to a regular maintenance according to manufacturer's indications. A zero check and a typical value check should be performed by comparison with standard certified gas. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Values to be averaged hourly. Monthly recording.
Any comment:	Measurement instruments may read ppmv or %-values. To convert from ppmv to mg/m3 multiply by 0.716. 1% corresponds to 10,000 ppmv.

Data / Parameter:	**T_{flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data used:	Thermocouple
Description of measurement methods and procedures to be applied:	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple.
QA/QC procedures to be applied:	Thermocouples should be replaced or calibrated every year.
Monitoring frequency:	Continuously.
Any comment:	

Data / Parameter:	**EC_y**
Data unit:	MWh
Description:	Electricity consumption by the project equipment installed for the capture and flaring of landfill gas during the year *y*
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Electricity meter
QA/QC procedures to be applied:	The meters will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous.
Any comment:	All equipment installed due to the project activity and not directly linked to the recovery of energy. In case the electricity consumption of the latter group is not directly accounted for in the calculation of the net electricity generation from the gross generation, this electricity consumption will be metered separately, i.e. not together with the consumption of electricity by equipment installed for the capture and flaring of LFG.

{Following parameters only if LFG utilization is within project boundary}

Data / Parameter:	**$EG_{BL,y}$** (scenario 2a or 2c)**, $EG_{captelec,PJ,y}$** (scenario 2c), $EG_{PJ,electrical,y}$ (scenario 2c)
Data unit:	MWh
Description:	Quantity of net electricity displaced/produced by the project activity in year *y*
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Electricity meter. In case the project activity is exporting electricity to other facilities, the metering shall be carried out at the recipient's end.
QA/QC procedures to be applied:	The meters will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Hourly measurement. Monthly recording.
Any comment:	In case electricity is sold to a third party, the parameter is crosschecked with sales records. Net electricity is the gross electricity minus auxiliary consumption.

Data / Parameter:	**$EF_{CO2,grid,y}$**
Data unit:	tCO_2e/MWh
Description:	CO_2 emission factor of the grid in the year *y*
Source of data used:	Calculated or taken from latest version of Resolución 180947 according to case
Description of measurement methods and procedures to be applied:	Case a): Grid electricity displacement: Take yearly updated value of the Resolución 180947 Case b): Captive power plant: Calculate according to methodology
QA/QC procedures to be applied:	n/a
Any comment:	Scenario 2a or 2c

Data / Parameter:	**$EG_{thermal,y}$, $EG_{PJ,thermal,y}$**
Data unit:	TJ
Description:	Net quantity of steam/heat supplied by the project activity during the year *y*
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and if applicable any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. In case of equipment that produces hot water/oil this is expressed as the difference in the enthalpy between the hot water/oil supplied to and returned by the plant.

	In case of equipment that produces hot gases or combustion gases, this is expressed as the difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be determined based on the monitored mass flow, temperature, pressure, density and specific heat of the gas. In case the project activity is exporting heat to other facilities, the metering shall be carried out at the recipient's end and measurement results shall be cross checked with records for sold/purchased thermal energy (e.g. invoices/receipts).
QA/QC procedures to be applied:	The meters will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous monitoring. Aggregated annually.
Any comment:	Scenario 2b or 2c

Data / Parameter:	**EC_y**
Data unit:	MWh
Description:	Electricity consumption by the project equipment installed for the utilisation of captured landfill gas in heat generation processes during the year y.
Source of data used:	Metered
Description of measurement methods and procedures to be applied:	Electricity meter
QA/QC procedures to be applied:	The meters will be subject to a regular maintenance according to manufacturer's indications. Calibration will be according to national standards.
Monitoring frequency:	Continuous.
Any comment:	This parameter is monitored separately from the electricity consumption due to the capture of landfill gas. Applicable to scenario 2b.

C.1. Please indicate the level at which environmental analysis as per requirements of the CDM modalities and procedures is undertaken. Justify the choice of level at which the environmental analysis is undertaken:

☑ This information has been provided at the PoA level. Therefore, sections C.2. and C.3. are not completed.

C.2. Documentation on the analysis of the environmental impacts, including transboundary impacts:

n.a.

C.3. Please state whether an environmental impact assessment is required for a typical CPA, included in the programme of activities (PoA), in accordance with the host Party laws/regulations:

n.a.

SECTION D. Stakeholders' comments

D.1. Please indicate the level at which local stakeholder comments are invited. Justify the choice:

☑ This information has been provided at the PoA level. However, it has been decided to provide this information also at the CPA level. Therefore, sections D.2. to D.4. will be completed as applicable to this CPA.

D.2. Brief description how comments by local stakeholders have been invited and compiled:

[List publications, invitees (groups), public events indicating number of participants and date and location, describe system of collection of comments (e.g. questionnaires, protocol)]

D.3. Summary of the comments received:

[List comments received from different events]

D.4. Report on how due account was taken of any comments received:

[Describe how comments by stakeholders were taken into account in the implementation/design of the project activity, e.g. describe mitigation measures]

Annex 1

CONTACT INFORMATION ON ENTITY/INDIVIDUAL RESPONSIBLE FOR THE SMALL-SCALE CPA

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Annex 4

MONITORING INFORMATION

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