CLEAN DEVELOPMENT MECHANISM
SMALL-SCALE PROGRAMME OF ACTIVITIES DESIGN DOCUMENT FORM
(CDM-SSC-PoA-DD) Version 01

CONTENTS

Annexes

NOTE:

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

(ii) At the time of requesting registration this form must be accompanied by a CDM-SSC-CPA-DD form that has been specified for the proposed PoA, as well as by one completed CDM-SSC-CPA-DD (using a real case).

SECTION A. General description of small-scale programme of activities (PoA)

A.1 Title of the small-scale programme of activities (PoA):

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

Version 01, dated 21/10/2011

A.2. Description of the small-scale programme of activities (PoA):

1. General operating and implementing framework of PoA

CarbonBW Colombia S.A.S. will act as Coordinating and Managing Entity (CME) of the proposed programme of activities. CarbonBW Colombia S.A.S (in the following CarbonBW) is a full subsidiary of EnBW Kraftwerke AG (EnBW KWG), Germany. CarbonBW will act as owner, investor and operator of landfill gas activities in Colombia. Thereby its activities comprise of planning, design, construction and installation, operation, maintenance and repair of landfill gas (LFG) activities as well as renewable energy generation and/or sale of LFG to third party consumers. Apart from the technical implementation, CarbonBW manages the CDM process cycle including registration and monitoring.

CarbonBW was constituted according to Colombian law on August 10, 2010 as a simplified stock company (S.A.S.) with indefinite legal duration. The company is located in Bogota, Colombia (http://www.carbonbw.com). Currently, the company is involved in the implementation of landfill gas capture activities in the country. CarbonBW's staff is experienced in the implementation of landfill gas activities inside and outside Colombia and they are familiar with CDM activities.

2. Policy/measure or stated goal of the PoA

With respect to emission reductions, it is the goal of the proposed PoA to decrease methane emissions from landfills to the atmosphere at first place and at second place to contribute to sustainable development through the utilization of captured landfill gas where appropriate and financially viable. In the proposed PoA landfill gas is collected and either flared or utilized. Utilization can be for electricity and/or heat generation, for supply to consumers through pipelines or as fuel for transportation activities. Colombian regulations do not require the collection and destruction of landfill gas. According to regulations, a passive venting system must be installed at the landfills for safety reasons (stability of landfill and reduction of risk of fire).

The goals of this PoA can be summarized as follows:

- Capture/collection of landfill gas with or without subsequent utilization;
- Decrease of CDM transaction costs compared to the CDM-project mechanism with the purpose to develop also smaller CDM landfill gas activities that might not afford covering CDM transaction costs as stand-alone CDM project activities; and
- Quick inclusion of CPAs across the country after PoA registration for speeding up activity implementation.

LFG management and destruction is not prevailing practice in the host country and is not requested by law. All landfills that currently have a system to capture and flare or utilize the landfill gas have received incentives through the CDM.

According to the Super-Intendancy of Home and Public Services (Superintendencia de Servicios Públicos, SUI)[1] Colombians generate currently around 30,886 t of solid waste per day of which 92.54% is disposed of under controlled conditions (mainly to landfills) while the other 7.46% are disposed of in uncontrolled manner (e.g. dumpsites or burning) (see figure).

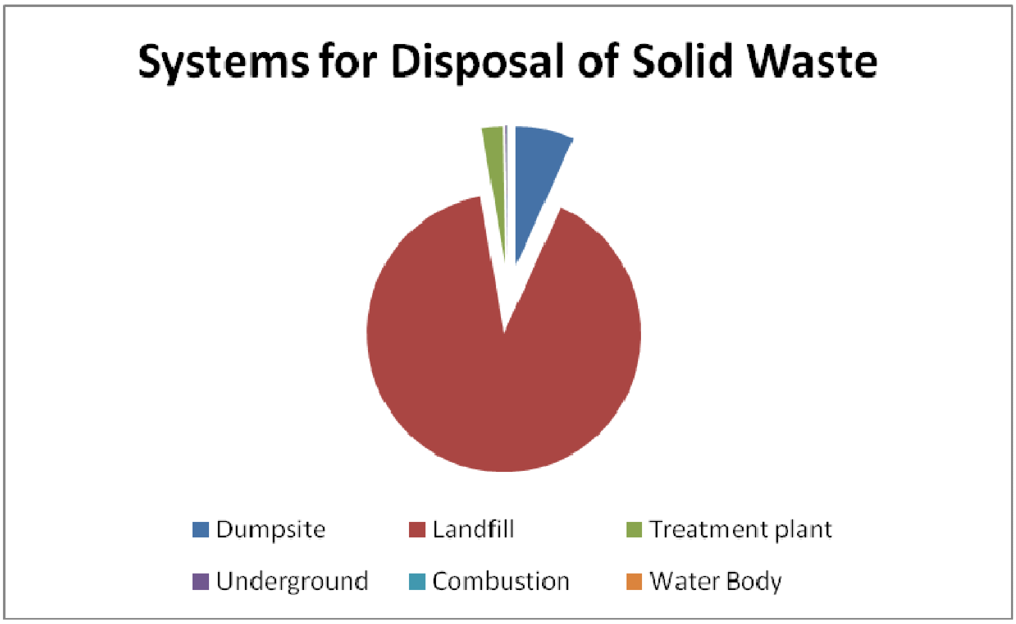

Figure 1: Final solid waste disposal in Colombia in 2008[2]

With respect to the roughly 1,000 municipalities interviewed by SUI collecting the above data, around 2/3 stated to dispose of municipal waste to 255 landfills while 1/3 stated to dispose of waste to 246 dumpsites, 7 uncontrolled burning sites, and 11 water bodies. Generally the situation is very different among Colombian provinces of which especially those in the Amazonas and the Coastal region dispose of municipal waste in inadequate manners. Against this background the national government formulated a policy to incentivize the installation of regional sanitary landfills, especially with the Law 1151 from 2007.

[1] S.A. Forero, M. Pilar Ochoa del, E. Nieves Díaz, and J.M. Salinas Ramirez (2009): Situación de la Disposición Final de Residuos Sólidos en Colombia- Diagnostico 2009.

[2] http://www.superservicios.gov.co/home/c/document_library/get_file?uuid=bcd04c23-976c-4244-9ed5-1685b66824fe&groupId=10122, 21-07-2011

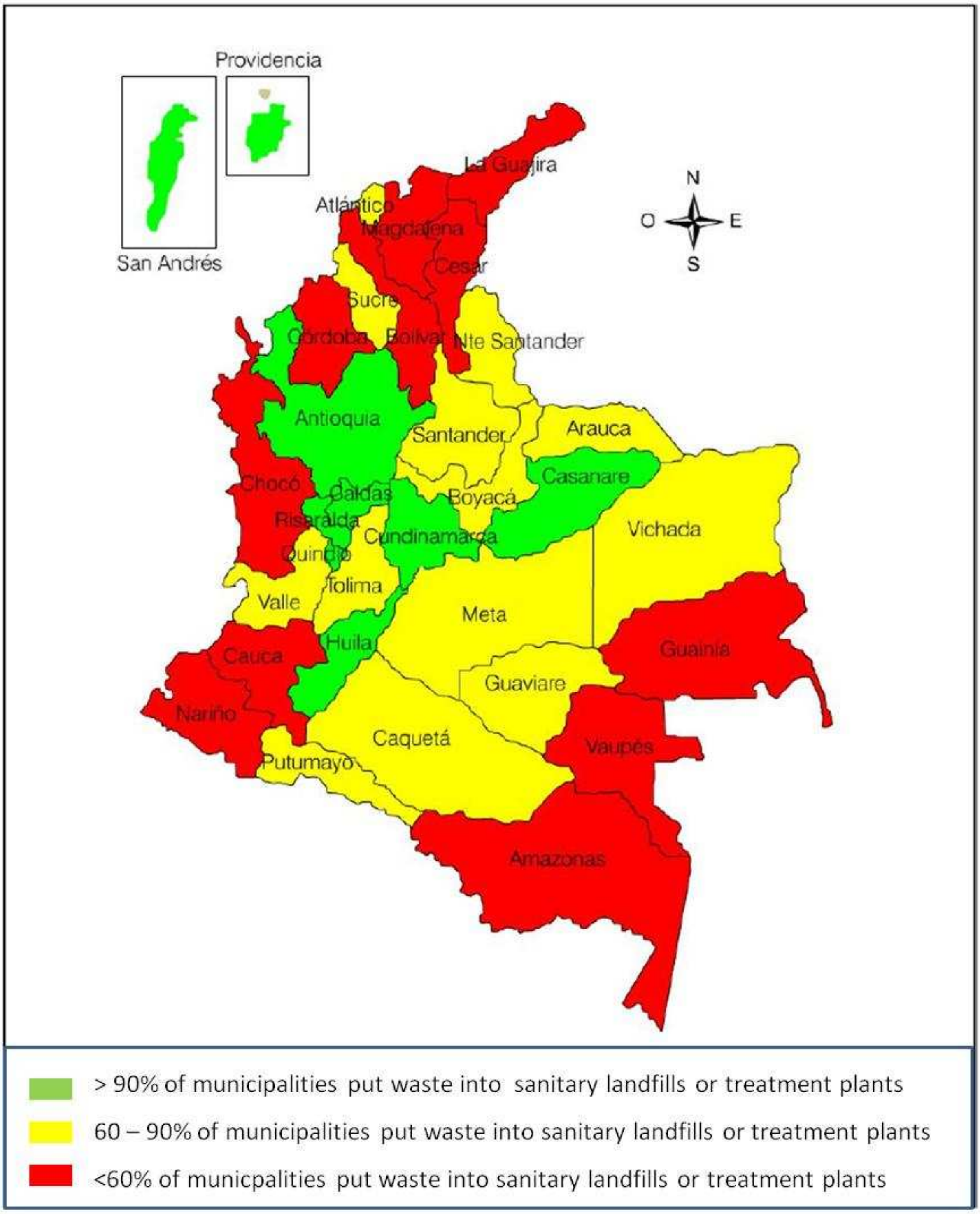

Figure 2: Municipalities and Sanitary Landfills or Treatment Plants in Colombia

3. Confirmation that the proposed PoA is a voluntary action by the coordinating/managing entity

CarbonBW's main task is to develop and implement CDM projects in Colombia. CarbonBW will voluntarily assume the role as a CME for the proposed PoA as described in this Design Document.

4. Contribution to sustainable development

The baseline scenario consists in the release of large amounts of GHG emissions to the atmosphere. Methane (CH_4) is a powerful GHG with a Global Warming Potential (GWP) that is 21 times higher that that of carbon dioxide (CO_2). It generates in landfills where organic material decomposes under anaerobic conditions. If not collected and destroyed it is released to the atmosphere and contributes to global climate warming. The regional and national government also follow the aim of mitigating climate warming. This aim, for example, is given expression in writing in the government document CONPES 3700, dated 30 July 2011 (Low Carbon Development Strategy of Colombia).

The total capture and destruction efficiency will be above roughly 50%. Other local odour nuisance is reduced by LFG combustion.

Apart, LFG utilization further represents a source of renewable, non-fossil energy. The proposed PoA foresees the exploitation of the energy source where appropriate. By substitution of fossil fuels, especially carbon dioxide emissions and local air pollution through dust or other particles can be reduced.

Within the proposed PoA, technology for the collection and the destruction or if applicable also for the utilization of the landfill gas, is imported to the host country. The host country is thus delivered examples of up-to-date technology that helps conserve our environment. In the event of landfill gas utilization further technology, e.g. for energy recovery from landfill gas is imported to the host country. This will illustrate different ways of gainful utilization of former "waste material", the landfill gas.

CarbonBW will recruit local personnel as far as appropriate for required services/ works. Further, CarbonBW itself has local staff, mainly Colombian engineers.

A.3. Coordinating/managing entity and participants of SSC-POA:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participant (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Colombia (host)	CarbonBW Colombia S.A.S.	No
Federal Republic of Germany	EnBW Kraftwerke AG	No
(*) in accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the small-scale programme of activities:

A.4.1. Location of the programme of activities:

The PoA is located in the Republic of Colombia

A.4.1.1. Host Party(ies):

The host party is the Republic of Colombia

A.4.1.2. Physical/ Geographical boundary:

The geographical boundary for this PoA is the Republic of Colombia (see Figure 2). All CDM programme activities (CPAs) included in the PoA will be implemented in within this geographical boundary taking into consideration applicable national and/or sectoral policies and regulations.

Figure 2: Map of Colombia[3]

[3] Source: http://www.nationsonline.org/maps/colombia_pol_map.jpg, 11-07-2011

A.4.2. Description of a typical small-scale CDM programme activity (CPA):

A typical CDM Programme Activity (CPA) consists of the capture of landfill gas at landfills in within the host country combined with flaring and/or gas utilization. A typical CPA either applies one of the following scenarios or a combination of scenarios whereby the combination can also be a stepwise implementation:

Description of typical CPA:
Scenario 1- "LFG Capture and Flaring": Capture of LFG at an eligible[4] landfill and flaring of LFG.

Scenario 2- "LFG Capture and Utilization for Direct Energy Recovery": Capture of LFG at an eligible landfill and utilization of LFG for direct renewable energy generation:

a) *Electricity generation*: Captured LFG is utilized to generate electricity displacing captive power generation in partially or totally fossil fuel fired power plants or grid electricity;
b) *Heat generation*: Captured LFG is utilized to generate heat for users in applications above 45 kW_{th}. The activity avoids the combustion of fossil fuels;
c) *Electricity and heat generation*: Captured LFG is utilized to generate both heat and electricity.

Scenario 3- "LFG Capture and Utilization without claiming CERs": Capture of LFG at an eligible landfill and utilization in one of the following ways although CERs will not be claimed for the latter. The distribution point is within the project boundary in order to monitor the total quantity of LFG either flared or utilized:

a) Upgrade and supply to consumers: After upgrading captured LFG is supplied through bottles or pipelines/distribution networks to consumers in the host country. Utilization might be in industrial processes involving kilns;
b) *Transportation activities*: Captured LFG is prepared to be finally consumed in transportation activities. The preparation can consist of cleaning, pressurizing or bottling;
c) *Any activity of scenario 2 without claiming CERs*: The landfill gas utilization activities described under scenario 2 can also be implemented without claiming CERs.

A.4.2.1. Technology or measures to be employed by the SSC-CPA:

A typical CPA under this PoA will involve the installation of a landfill gas collection and flaring or utilization system to an open or closed landfill[5]. In terms of technology, the scenarios can be described as follows:

- **Scenario 1- "LFG Capture and Flaring":** All LFG collected at the landfill will be conducted to a flare which is on-site and be directly flared. The technology thus comprises of a LFG collection system, and a flaring station. The technical parameters of the installed systems will be provided in each specific CPA-DD.

[4] Eligibility criteria will be discussed later in this document

[5] 'Open' characterizes a landfill where still waste is and will be deposited while 'closed' characterizes a landfill that does not receive waste anymore.

Collection System:

- Gas wells (vertical wells in flat parts of the landfill and horizontal wells in the steep parts) and equipped with wellheads for gas measurements;
- Connection pipelines between gas wells and flaring station; in the case of open landfills, these systems are usually designed as modular system in order to allow for future extensions;
- Leachate monitoring in vertical wells: Leachate levels in vertical wells will be measured and recorded regularly.

Flaring Station:

- Electric blowers 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 will be well above 900 °C with accepted methane concentrations between 30% and 70% and a flaring efficiency above 99%;
- Web-based remote supervision and control of the flare;
- Automatic alarm system to assure that the equipment is always operating under safety conditions; and
- Security restart system in case of system shut down.

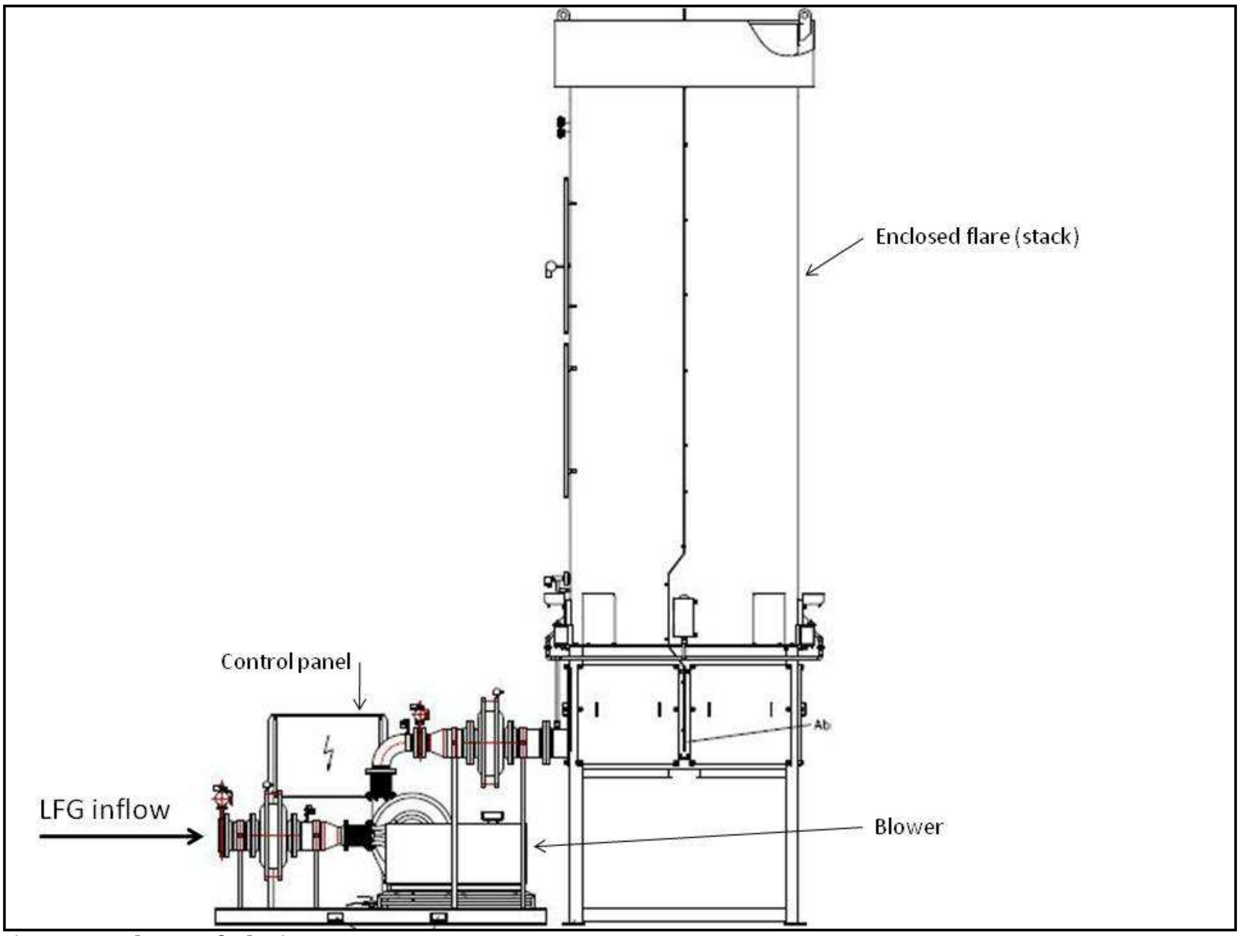

Figure 3: Scheme of Flaring System

- **Scenario 2a- "LFG Capture and Utilization for Direct Electricity Generation":** This scenario comprises of the above described collection system (Scenario 1) plus gas preparation and a power generation set. Co-generation units are included in scenario 2c. The additional components are:
  - Gas drying equipment to remove moisture from gas before combustion;
  - Gas cleaning equipment (e.g. activated carbon) to remove impurities especially sulphur and other potentially harmful substances;
  - Gas engine suited to the combustion of methane rich gases;
  - Power generator driven by the gas engine;
  - In case of grid connection for export of surplus electricity, a substation with cable connection and possibly a transformer to increase voltage; and
  - Enclosed flare for periods of engine shutdown (e.g. for maintenance) or for exuberant gas production.

- **Scenario 2b- "LFG Capture and Utilization for Direct Heat Generation":** This scenario comprises of the above described collection system (scenario 1) plus heat recovery equipment like boilers equipped with gas burners or multi-fuel burners. Co-generation units are included in scenario 2c. The additional components are:
  - Gas drying equipment to remove moisture from gas before combustion;
  - Gas cleaning equipment (e.g. activated carbon) to remove impurities especially sulphur;
  - Heat boiler or other heat generation equipment; and
  - Enclosed flare for periods of engine shutdown (e.g. for maintenance) or for exuberant gas production.

- **Scenario 2c- "LFG Capture and Utilization for Direct Heat and Electricity Generation":** This scenario comprises of the above described collection system (Scenario 1) plus heat recovery equipment or a co-generation system for heat and electricity generation. The additional components are:
  - Gas drying equipment to remove moisture from gas before combustion;
  - Gas cleaning equipment (e.g. activated carbon) to remove impurities especially sulphur and other potentially harmful substances;
  - Co-generation system;
  - In case of grid connection for electricity export, a substation with cable connection and possibly a transformer to increase voltage; and
  - Enclosed flare for periods of shutdown (e.g. for maintenance) or for exuberant gas production.

- **Scenario 3a- "LFG Capture and Utilization after upgrading and distribution or bottling":** This scenario comprises of the above described collection system (Scenario 1) plus upgrading and bottling unit or distribution network (including dedicated pipelines or natural gas distribution network). After distribution, the final consumption might involve kilns (e.g. in brick factories) where LFG is combusted. The mentioned equipment is not included in the project boundary and thus not described in the following.

- **Scenario 3b- "LFG Capture and Utilization in transportation activities":** This scenario comprises of the above described collection system (Scenario 1) plus a gas preparation system for drying, cleaning, and purification and compressing system to obtain up-graded LFG such that methane content, its quality and the physical and chemical properties are similar to Compressed Natural Gas (CNG). The produced bio-CNG can be used in various types of transportation applications such as CNG-vehicles or modified gasoline vehicles like buses. The project boundary is at the site where landfill gas is prepared for its utilization in transportation activities. The equipment for the preparation of the LFG and the transportation activity itself is not included in the project boundary and thus not described in the following.

- **Scenario 3c- "LFG Capture and Utilization in direct energy recovery without claiming CERs":** This scenario is for the activities as described under scenario 2 but without claiming CERs. The technology applied is thus the same as described above under the relevant scenario 2.

A.4.2.2. Eligibility criteria for inclusion of a SSC-CPA in the PoA:

The criteria for determining additionality will be described in section E.5. Here only eligibility criteria will be listed.

Table 1: Eligibility Criteria for Inclusion of a CPA into the PoA

ID	Criterion
1	Open or closed landfill for household/ urban waste.
2	For the landfill gas, the baseline scenario consists of the total or partial release of LFG to the atmosphere.
3	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.
4	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.
5	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.
6	The landfill keeps the Environmental Norms of Colombia (e.g. Law 99/93) and provides the relevant documents.[6]
7	The landfill where the waste is deposited can be clearly identified to set the geographic boundary and for its unique identification.
8	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.
9	Landfill gas from hazardous waste cells (if any) is not included in the capture system.
10	The *ex-ante* calculated emission reduction due to methane destruction from the landfill is limited to 60 ktCO_2e/year.
11	Stakeholder consultation requirements are followed as per the DNA of the host country.
12	Additionality has been confirmed according to the below defined additionality eligibility

[6] Landfills that started operation after December 22nd, 1993 are required to provide an Environmental License and Environmental Management Plan and EIA. Others are required to provide an Environmental License. Law 99/93 and previous respective later applicable laws.

	criteria.

In line with Annex 3, CDM EB 63, "Standard for the development of eligibility criteria for the inclusion in a Programme of Activities", the eligibility criteria should further include:

1) The specification of the technology/measure including the level and type of service, performance specifications including compliance with testing/certifications;
2) Conditions that ensure compliance with applicability criteria and other requirements of single or multiple methodology/ies applied by CPAs;
3) The requirements for the debundling check; and
4) Conditions to check the start of the CPA through documentary evidence.

Criterion 1) will be fulfilled by data provided by the CME. This is special, as the CME in the proposed POA will also act as project implementer.
Criterion 2) will be discussed in the section below where further eligibility criteria specified according to the additional methodology applied are defined.
Criterion 3) is verified according to the above criterion No. 8, but will be appended by a confirmation by the CME that it is not managing/coordinating another LSC PoA in the PoA-boundary.
Criterion 4) will be supplemented by documents provided by the CME as the project implementer (dates of contact with the landfill owner, order of project equipment, etc.).

Table 2: Additional Eligibility Criteria for Inclusion of a Scenario 2-CPA into the PoA

ID	Criterion
11	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.
12	The aggregate installed capacity is below 45 MW_{th} for heat or co-generation activities, or respectively below 15 MW_{el} for electricity only activities.
13	In case of electricity displacement, electricity is not displaced from a mini-grid system.
14	Displaced energy generation would not be in a co-fired (i.e. biomass and fossil fuels) system.
15	The renewable energy generation unit installed due to the project activity is not a capacity addition to an existing energy generation plant.
16	The energy baseline excludes the generation of thermal and/or electrical energy, partially or totally, based on biomass.
17	In case the project activity retrofits an existing plant, the existing plant is operated exclusively on fossil fuels.

Table 3: Additional Eligibility Criteria for Inclusion of a Scenario 3-CPA into the PoA

ID	Criterion
18	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.

A.4.3. Description of how the anthropogenic emissions of GHG by sources are reduced by a SSC-CPA below those that would have occurred in the absence of the registered PoA (assessment and demonstration of additionality):

The additionality assessment follows the stipulations of the "Simplified modalities and procedures for small-scale CDM project activities", Attachment A to Appendix B. These ask project participants to provide an explanation why the activity would not have occurred anyway due to at least one of the following barriers:

- Investment barrier;
- Technological barrier;
- Barrier due to prevailing practice; or
- Other barriers.

The demonstration of additionality for CPAs will be based on the demonstration of an investment barrier, i.e. a financially more viable alternative to the project activity would have led to higher emissions. An investment barrier is proven in two different ways depending on before defined scenarios:

Scenario 1- "LFG Capture and Flaring":
The additionality of the proposed PoA, scenario 1, is justified by the following two arguments:

i. The proposed PoA is a voluntary coordinated action, i.e. participation of CPAs is on a voluntary basis.
ii. Scenario 1 of the proposed PoA would not be implemented in the absence of the CDM as CPAs do not generate any financial revenues apart from CERs.

There is no regulation in the host country that forces destruction of landfill gas emissions and there are no public incentives to engage in this activity (apart from the CDM). It is common practice in the host country to vent landfill gas through passive ventilation systems to the atmosphere.
Without CDM revenues and technical assistance in the installation, operation and maintenance, and monitoring of such a system, landfill owners in the host country would not engage in capturing LFG.

As this is the case for all CPAs that apply scenario 1, i.e. that only collect and flare landfill gas it is not necessary to demonstrate other barriers. It suffices to demonstrate that landfill gas is flared and that the participation in the PoA is voluntary.

Scenarios 2- "LFG Capture and Utilization for Direct Heat and/or Electricity Generation":
The additionality of the proposed PoA, scenarios 2, is justified by the following two arguments:

i. The proposed PoA is a voluntary coordinated action, i.e. participation of CPAs is on a voluntary basis.
ii. Scenarios 2 of the proposed PoA would not be implemented in the absence of the CDM as CPAs have a financially more attractive alternative which is not to invest.

To demonstrate that it is financially more attractive for CPAs not to invest, an investment analysis for each type of landfill gas utilization according to the different cases under scenario 2 will be done on CPA-level. Thereby the general rules/assumptions of the latest version of the "Guidelines on the assessment of investment analysis" will be applied. Currently, the latest version is from CDM EB 61, Annex 13 stipulates:

- Consideration period: The period of assessment for the investment analysis will be fixed to 20 years or the operational lifetime of the activity, whatever is shorter. If

applicable, the fair value of assets at the end of the consideration period will be taken into account in the final year;
- The input values will be taken as valid at the time of investment decision;
- The financial indicator is defined as a the Net Present Value (NPV);
- In the calculation of the NPV the discount factor will be applied as defined in "Guidelines on the assessment of investment analysis". Currently, two options are provided out of which the second one foresees the utilization of predefined national values.
  The relevant discount factor for the energy sector of Colombia is currently 12.0% in real terms (Annex B, Guidelines on the assessment of investment analysis);
- A sensitivity analysis for the parameters "investment cost" and "O&M costs" will be applied with a variation of ±10%.

To conclude the results of the investment analysis, a comparison of the NPV with and without CER-revenues is done. In the event the NPV without CER-revenues is negative for CarbonBW (the CME), the CPA is deemed additional.

In case LFG is sold to third parties a reasonable price for LFG shall be assumed and the calculations/ assumptions be justified.

Scenarios 3- "LFG Capture and Utilization without CERs":
The additionality of the proposed PoA, scenarios 3, is justified by the following two arguments:

i. The proposed PoA is a voluntary coordinated action, i.e. participation of CPAs is on a voluntary basis.
ii. Scenarios 2 of the proposed PoA would not be implemented in the absence of the CDM as CPAs have a financially more attractive alternative which is not to invest.

Usually, the reason for not claiming CERs from the utilization of LFG will be the small size of the activity and/or the complex monitoring and/or the non-availability of an approved methodology combination under the PoA. In order to account for potential revenues from the sale of landfill gas an investment analysis will be done. Thereby the same assumptions as for the analysis of scenarios 2 are made.

To conclude the results of the investment analysis, the CPA is deemed additional if the NPV (without CERs) is negative for CarbonBW (the CME).

Supporting evidence:
Apart from the investment barrier, landfill gas projects in the host country have only been spread through the incentives given by the CDM. LFG capture projects would not have been developed without the incentives given by the CDM. Municipalities or other landfill owners would neither have the economical funds to develop LFG projects nor any financial interest to invest in such projects.

Table 4: Overview Landfill Projects (including Composting) in Colombia[7]

Title	Province / State	Status
Centro Industrial del Sur Organic Waste Project	Antioquia	Registered
Biorgánicos Organic Waste Project	Risaralda	Registered
Curva de Rodas and La Pradera landfill gas management project	Antioquia	Registered
Doña Juana landfill gas-to-energy project	Bogotá	Registered
Bionersis landfill project in Pasto, Colombia	Nariño	Registered
Bionersis LFG project Colombia 2	Santander	Registered
Bionersis LFG projects Colombia 4	Norte de Santander, Caldas	Registered
Bionersis LFG project Colombia 3	Meta	Registered
El Guacal Landfill Gas Flaring Project	Antioquia	Registered
Pirgua Landfill gas recovery and flaring	Boyacá	reg. request
Interaseo Landfill Gas Mitigation Project	Tolima, Cesar, Magdalena, Sucre	Validation terminated
La Esmeralda Landfill Gas Project 1	Caldas	Validation terminated
Guayabal Landfill Gas Project	Norte de Santander	Validation terminated
Montenegro Landfill gas recovery and flaring	Quindío	At Validation
Montería Landfill gas recovery and flaring	Córdoba	At Validation
El Henequén Landfill Gas Project	Atlántico	At Validation
Aerobic composting of paper sludge for methane emissions avoidance in Cundinamarca, Colombia	Cundinamarca	At Validation
Parque Ambiental Los Pocitos Landfill Gas Utilization Project	Atlántico	At Validation
Proactiva Presidente landfill gas to energy project	Cauca	At Validation
The Colomba-Guabal Landfill Gas Project	Valle del Cauca	At Validation
Los Angeles Landfill Gas Flaring Project	Huila	At Validation
Cartagena Landfill Gas Capture and Usage Project	Bolívar	At Validation

[7] Based on: http://cdmpipeline.org/publications/CDMpipeline.xlsx, Version 1st July 2011

A.4.4. Operational, management and monitoring plan for the programme of activities (PoA):

A.4.4.1. Operational and management plan:

In the operation and management of the PoA, the CME will follow the following procedure:

1. Identification of interested and eligible landfills

The landfill owner and the CME will discuss general requirements to be an eligible CPA in the PoA.

2. Data Gathering

The CME will do a preliminary gathering of data like deposition of and forecast of quantities of waste, waste composition, climate data, etc. Based on these data the CME will generate a preliminary estimate of expected costs and emission reductions.

3. Negotiations about gas concession contract

The CME and the landfill owner will enter into negotiations about a gas concession contract. Thereby, the CME has the goal to acquire the gas concession rights for the development of a CDM-activity.

4. Double-Counting Avoidance System

In order to avoid double-counting the landfill owner is asked to confirm in writing that the landfill is not part of another registered CDM-project activity or another registered PoA. For cross-check purposes, the CME verifies this with the official CDM website of the UNFCCC about registered CDM-activities (CPA and CDM-project activity). The geo-coordinates of the activities thereby serve as unique identifier.

5. CPA-DD Preparation

After previous checks have been completed the CPA-DD is prepared. The documents required in the turn of the eligibility check are checked for their completeness. Once the CPA-DD is finished and all necessary documents are available, the information is submitted to the DOE, and the DOE is requested to include the CPA into the PoA.

6. CPA Implementation

The CME organizes the implementation of the activity at the project site. After finalizing technical planning, equipment can be installed. As the CME is also responsible for monitoring of the CPA, the CME will have familiarized with monitoring requirements according to the described monitoring plan and install monitoring equipment accordingly.

7. Recording Keeping System for each CPA under the PoA

The CME establishes a centralized database at its offices. This database will record the name of the landfill, the geo-coordinates for its unique identification, the date of inclusion into the PoA, the gas utilization if any, and the crediting period. Each CPA included into the PoA will be inserted in the database. Further, throughout the lifetime of the PoA, the verification of each CPA will be listed. Each CPA contained in the database will be assigned a unique identification number.

8. Monitoring

The maintenance and calibration of monitoring equipment will be according to the definitions in the monitoring plan. The responsible entity is the CME. This assures maximum accuracy through experienced staff managing also other comparable activities.

A.4.4.2. Monitoring plan:

The monitoring will be for each CPA included into the PoA. Sampling of CPAs is not foreseen thus achieving maximal representation accuracy. The organisation of the higher monitoring effort can be handled though, through the centralization of monitoring obligations to the CME. The CME will make use of web based transfer of monitoring data and control of monitoring equipment.

Data Collection: The CME will produce weekly monitoring protocols for each CPA based on a web based system collecting the data from all CPAs electronically. The CME is responsible for the monitoring and data collection. The landfill operators will only be instructed in operation of equipment as far as relevant. After data collection the CME will check data for completeness and robustness. For safety reasons, data is stored on-site and in the offices of the CME.

Data Storage: The collected monitoring data will be stored for at least 2 years after the end of the crediting period of each CPA. The storage will be centralized.

Calibration and Maintenance: The CME will organize calibration according to national standards in the host country. Further, monitoring equipment will be maintained according to manufacturers' indications.

Training: CarbonBW will provide technical support/training to assist the landfill site operators as long as assistance is required. Occasional field visits by the CME to the landfills will be performed.

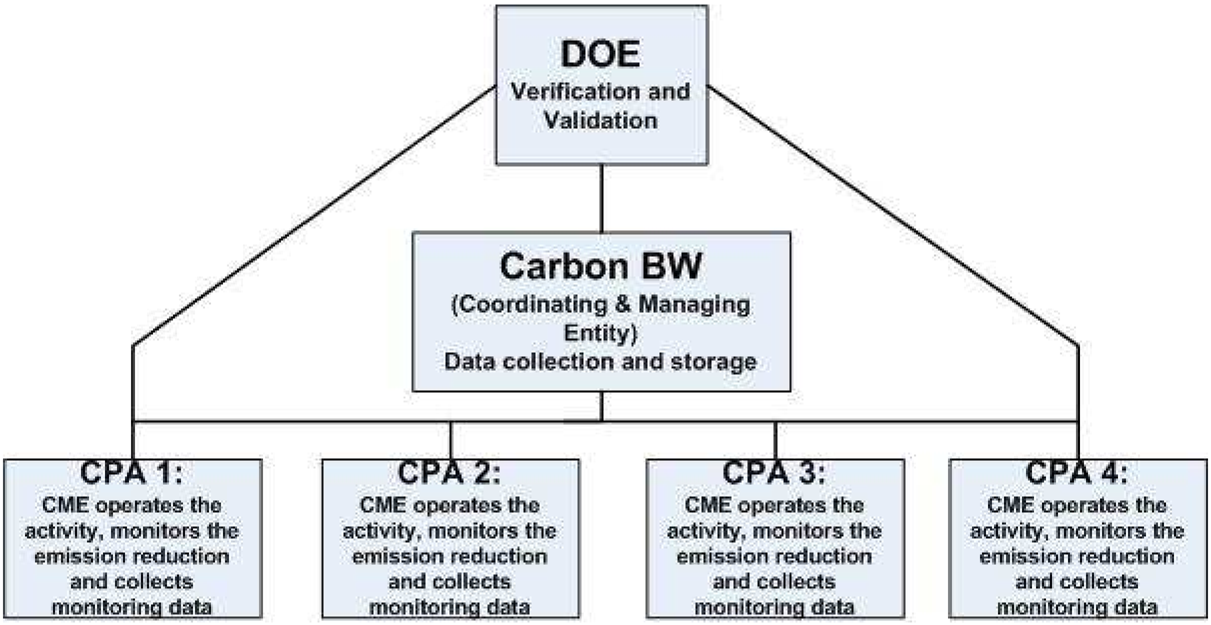

Figure 4: Overview of Monitoring Plan Responsibilities

A.4.5. Public funding of the programme of activities (PoA):

The proposed Programme of Activities has not received any public funding.

SECTION B. Duration of the programme of activities (PoA)

B.1. Starting date of the programme of activities (PoA):

01/10/2011 (or when the PoA-DD is published for Global Stakeholder Consultation) (whatever is later)

B.2. Length of the programme of activities (PoA):

28 years

SECTION C. Environmental Analysis

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:

1. Environmental Analysis is done at PoA level ☑
2. Environmental Analysis is done at SSC-CPA level ☐

Environmental Analysis is done at PoA level as in Colombia no EIAs are required for landfill gas capture activities (Law 99/1993 and Decree 2820/2010). Only the operation of a landfill might require an EIA and an Environmental Management Plan (EMP) depending on the starting date of operation of the landfill. These documents will be presented during validation for each CPA. However, as mentioned, the EIA and eventual EL are not required for the proposed activity of "LFG capture".

In case of landfill gas utilization by the CPA an EIA is not required for the utilization activity. This applies to direct utilization (e.g. if LFG is sold to production industry operating on fossil fuels) and indirect utilization (e.g. if grid electricity is displaced).

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

The PoA will reduce global as well as local environmental impacts by capturing LFG which would otherwise be released to the atmosphere. LFG consists mainly of methane and carbon dioxide and contributes to odour nuisance. Normally the majority of LFG emissions are quickly diluted in the atmosphere, though in confined spaces there is a risk of asphyxiation and/or toxic effects if present in high concentrations. In order to avoid self-ignition LFG is usually (passively) vented from landfills in the host country. This venting, however, does not prevent the odour nuisance to the surrounding public. Once

emitted to the atmosphere, LFG methane is a powerful greenhouse gas and 21 times more powerful than carbon dioxide (according to GWP_{100}).
On top of that, LFG contains over 150 trace gas components that can cause other negative local and global environmental impacts such as stratospheric ozone layer depletion and ground level ozone creation.

Although the destruction efficiency will vary according to scenario (i.e. between flaring and the relevant gas utilization options), the LFG emissions to the atmosphere will be reduced in either way. Construction is mainly limited to landfill sites and negative impacts from this activity are not expected.

Negative transboundary impacts due to the implementation of the proposed PoA are not expected.

In summary the impacts are the following:

- Reduced emissions of the powerful greenhouse gas methane;
- Reduced emissions of other trace gases (more than 150 different gases);
- Decreased odour nuisance;
- Improved general sanitary conditions due to lower attraction of flies and inhibited outbreak of pests; and
- Improved stability of correctly degassed landfill.

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

An Environmental Impact Assessment (EIA) is not required for the typical CPA included in the proposed PoA. An EIA is not required by Colombian legislation for LFG capture and destruction activities (scenario 1- LFG flaring) and it is not required for LFG capture and utilization activities (scenarios 2, 3- LFG Utilization).

SECTION D. Stakeholders' comments

The stakeholder consultations will be held, documented, and included into CPA-documentation as described in the following subsections.

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

1. Local stakeholder consultation is done at PoA level ☑
2. Local stakeholder consultation is done at SSC-CPA level ☑

Due to the fact each CPA is assumed to achieve significant emission reductions below baseline levels, local stakeholder consultation will be done at CPA level. Further, CPAs are potentially spread across the entire country. Doing the stakeholder consultation at CPA level thus allows stakeholders to comment on CPAs which are in their proximity.

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

In the preparation of the stakeholder consultation the following three sources have been considered:

1. Resolution 2733, dated 29/12/2010 and published by the Ministry for the Environment, Housing and Rural Development (Spanish: Ministerio de Ambiente, Vivienda y Desarrollo Rural) stipulates the requirements for the national approval of CDM-PoAs in Colombia;
2. Any other relevant host-country legislations;
3. Recommendations by the host-country DNA; and
4. The CDM procedures.

To support the local stakeholder participation and the awareness of the existence of the PoA, a stakeholder consultation will also be done on national-/PoA-level. This stakeholder meeting will take place on the 16th of November 2011 in Bogotá.

For the local Stakeholder Consultation at CPA-level as well as at the PoA-level, the invitations will be published in a national magazine and invitation letters will be sent to the stakeholders identified by the CME and the owner of the CPA.

D.3. Summary of the comments received:

Summary of comments on national level to be included later.
Since local stakeholder consultations will be held on CPA level, comments received will be presented in the specific CPA-DDs.

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

For national level to be updated later.
Since local stakeholder consultations will be held on CPA-level, reports on how due account was taken for any comments received will be presented in the specific CPA-DDs.

SECTION E. Application of a baseline and monitoring methodology

This section shall demonstrate the application of the baseline and monitoring methodology to a typical SSC-CPA. The information defines the PoA specific elements that shall be included in preparing the PoA specific form used to define and include a SSC-CPA in this PoA (PoA specific CDM-SSC-CPA-DD).

E.1. Title and reference of the approved SSC baseline and monitoring methodology applied to a SSC-CPA included in the PoA:

The following approved baseline and monitoring methodology will be applied to each CPA included in the proposed PoA:

- AMS-III.G*" Landfill methane recovery"* - Version 7.0

For "Scenarios 2- LFG Capture and Utilization in Type-I Component" further one or a combination of the following methodologies might be applied to a CPA included in the proposed PoA:

- AMS-I.C "*Thermal energy production with or without electricity*"- Version 19.0;
- AMS-I.F "*Renewable electricity generation for captive use and mini-grid*"- Version 02;

The following methodological tools will thereby be considered:

- "Tool for the demonstration of additionality"- Version 5.2.1;
- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"- Version 5.1.0;
- "Tool to calculate the emission factor for an electricity system"- Version 2.2.0;
- "Tool to determine project emission from flaring gases containing methane"- Version 1.0;
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"- Version 2.0; and
- "Tool to calculate baseline, project, and/or leakage emission from electricity consumption"- Version 01.

E.2. Justification of the choice of the methodology and why it is applicable to a SSC-CPA:

Table 5: Comparison Methodology and Project

Methodology AMS-III.G	Project Activity
Measures to capture and combust methane from landfills used for disposal of residues from human activities including municipal, industrial, and other solid waste containing biodegradable organic matter.	The proposed PoA includes CPAs that will capture methane from solid waste disposal sites.
The recovered methane from the above measures may also be utilised as detailed in AMS-III.H: *(a)* Thermal or mechanical, electrical energy generation directly; *(b)* Thermal or mechanical, electrical energy generation after bottling of upgraded biogas; *(c)* Thermal or mechanical, electrical energy generation after upgrading and distribution using one of the following options: *(i)* Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraint; *(ii)* Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or *(iii)* Upgrading and transportation of biogas to distribution points for end users. *(d)* Hydrogen production; *(e)* Use as fuel in transportation applications after upgrading.	CPAs included in the PoA can alternatively utilize the captured LFG instead of flaring. In case a combination of SSC methodologies is necessary, the "General guidelines to SSC CDM methodologies" or cross effects according to the "Standard for the application of multiple CDM methodologies for a Programme of Activities" is applied.
Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO_2e annually from all type-III-components of the project	CPAs under this PoA are small-scale projects with aggregated emission reductions of less than 60 ktCO_2e

activity.	annually for the landfill methane recovery and other type-III-components, if applicable.
Methodology AMS-I.C	**Project Activity**
1. This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels.	Energy generation is from LFG fired within renewable energy technologies. Supply to individual households is not included in the project activity but other users will be focussed. Fossil fuels will be displaced.
2. Biomass-based co-generating systems that produce heat and electricity are included in this category.	Cogeneration units might be installed under the PoA.
3. Where thermal generation capacity is specified by the manufacturer, it shall be less than 45 MW. This applied for co-fired systems, a case in which the aggregate installed capacity has to be taken into account and to cogeneration projects that displace/avoid fossil fuels.	The installed aggregate capacity in a relevant CPA shall be less than $45MW_{th}$.
4. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should be lower than 45 MW_{th} and should be physically distinct from the existing units.	Capacity additions to existing renewable energy facilities are excluded from the PoA.
5. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.	Retrofits of existing renewable energy generation units are excluded from the PoA.
6. If recovered energy is delivered to a third party within the project boundary, a contract between the supplier and consumer(s) will be entered that ensures that there is no double counting of emission reductions.	This is an eligibility criterion for inclusion of a project activity (CPA) into the PoA.
Methodology AMS-I.F	**Project Activity**
1. Renewable energy generation units that displace electricity from a grid that is connected to at least one fossil fuel fired generating unit.	Generation is by technologies that recover energy from LFG. Since LFG is a renewable fuel, the technologies can be deemed renewable energy generation units. The displacement of energy is for grid electricity or electricity generated by captive fossil fuel fired units.
2. Hydropower plants are eligible under certain conditions	Irrelevant. Hydropower CPAs are not eligible in this PoA.
3. For biomass power plants, no biomass other than renewable biomass is consumed.	The PoA is not for biomass power plants. Either way LFG qualifies as renewable.
4. The added/retrofitted/replaced or new renewable energy generation unit has a capacity not exceeding 15 MW_e.	Due to the size of the landfill gas projects, the energy recovered from the captured LFG will certainly remain below 15 MW_e.
5. Cogeneration systems are not eligible.	Cogeneration systems are eligible under

	the PoA, but will be accounted for under AMS-I.C.
6. If recovered energy is delivered to a third party within the project boundary, a contract between the supplier and consumer(s) will be entered that ensures that there is no double counting of emission reductions.	This is an eligibility criterion for inclusion of a project activity (CPA) into the PoA.

"Tool for determining methane emissions avoided from disposal of waste at a solid waste disposal site" – Version 5.1.0
The tool is applicable in cases where the solid waste disposal site where the waste would be dumped can be clearly identified. It is not applicable to stockpiles and hazardous wastes.

☑ CPA: Yes, the disposed site where the waste would be dumped can be clearly identified.

"Tool to determine project emissions from flaring gases containing methane" – Version 01
The tool is applicable to projects where residual gas stream to be flared shall be obtained from decomposition of organic material and where no gases other than methane, carbon monoxide, and hydrogen are contained.

☑ CPA: Yes, the residual gas stream is from a municipal landfill, i.e. a place where organic material decomposes and LFG typically contains no other gases than methane, carbon monoxide, and hydrogen.

"Tool to calculate the emission factor for an electricity system"- Version 02.2.0
This tool is applicable where a project activity supplies electricity to a grid or results in savings of grid electricity. If the PES is partially or totally located in an Annex-I country the tool is not applicable.

☑ CPA: Yes, the PA might supply electricity to a grid or might result in savings of grid electricity while the PES is located in the host country and thus in a Non-Annex-I country.

"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" – Version 02
This tool provides procedures to calculate project and/or leakage CO_2 emissions from the combustion of fossil fuels. It can be used in cases where CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and its properties.

☑ CPA: Yes, the CPA might consume and combust fossil fuels.

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" – Version 1
The tool is applicable if either electricity is consumed from the grid or electricity consumption is from off-grid fossil fuel fired captive power plants or electricity consumption is from the grid and fossil fuel fired captive power plants.

☑ CPA: Yes, these scenarios might be applicable to a project activity under the PoA.

E.3. Description of the sources and gases included in the SSC-CPA boundary

Scenario 1: In line with AMS-III.G, the project boundary is limited to the physical site of the landfill site where landfill gas is captured.

***

Scenario 2-a: In line with AMS-III.G, the project boundary is limited to the physical site of the landfill site where landfill gas is captured. In line with AMS-I.F, the project boundary further includes:

- The project site where electricity is generated; and
- The electricity system from which electricity is displaced.

****

Scenario 2-b: In line with AMS-III.G, the project boundary is limited to the physical site of the landfill site where landfill gas is captured. In line with AMS-I.C, the project boundary further includes:

- The project site where heat is generated; and
- If heat is provided to third parties, all the facilities (industrial, commercial or residential) that consume the heat and the processes or equipment affected.

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Scenario 2-c: In line with AMS-III.G, the project boundary is limited to the physical site of the landfill site where landfill gas is captured. In line with AMS-I.C, the project boundary further includes:

- The project site where heat and/or power is generated;
- All power plants connected physically to the electricity system; and
- If energy is provided to third parties, all the facilities (industrial, commercial or residential facilities) that consume the generated energy by the system and the processes or equipment affected by the project activity.

***

Scenarios 3-a-c: In line with AMS-III.G, the project boundary is limited to the physical site of the landfill site where landfill gas is captured.
Due to the utilization of captured landfill gas the boundary is expanded to the point where landfill gas is given to consumer (not necessarily the final consumer, e.g. in case of utilization of LFG by a bottling company for transportation activities). In case of scenario 3-a, this is the point where LFG enters the consuming process/facility. In case of scenario 3-b, this is the point where LFG enters the preparation plant (e.g. CNG recovery).
As CERs are not claimed from the utilization of LFG, the boundary is not expanded to the site where LFG is consumed. This is in accordance with § 12 – 13 of AMS-III.G. Monitoring is for the gas flow of methane recovered and gainfully used, fuelled or flared. The flow to these different fates is monitored at the point where landfill gas is given to consumers and monitoring is continuously with flow meters.

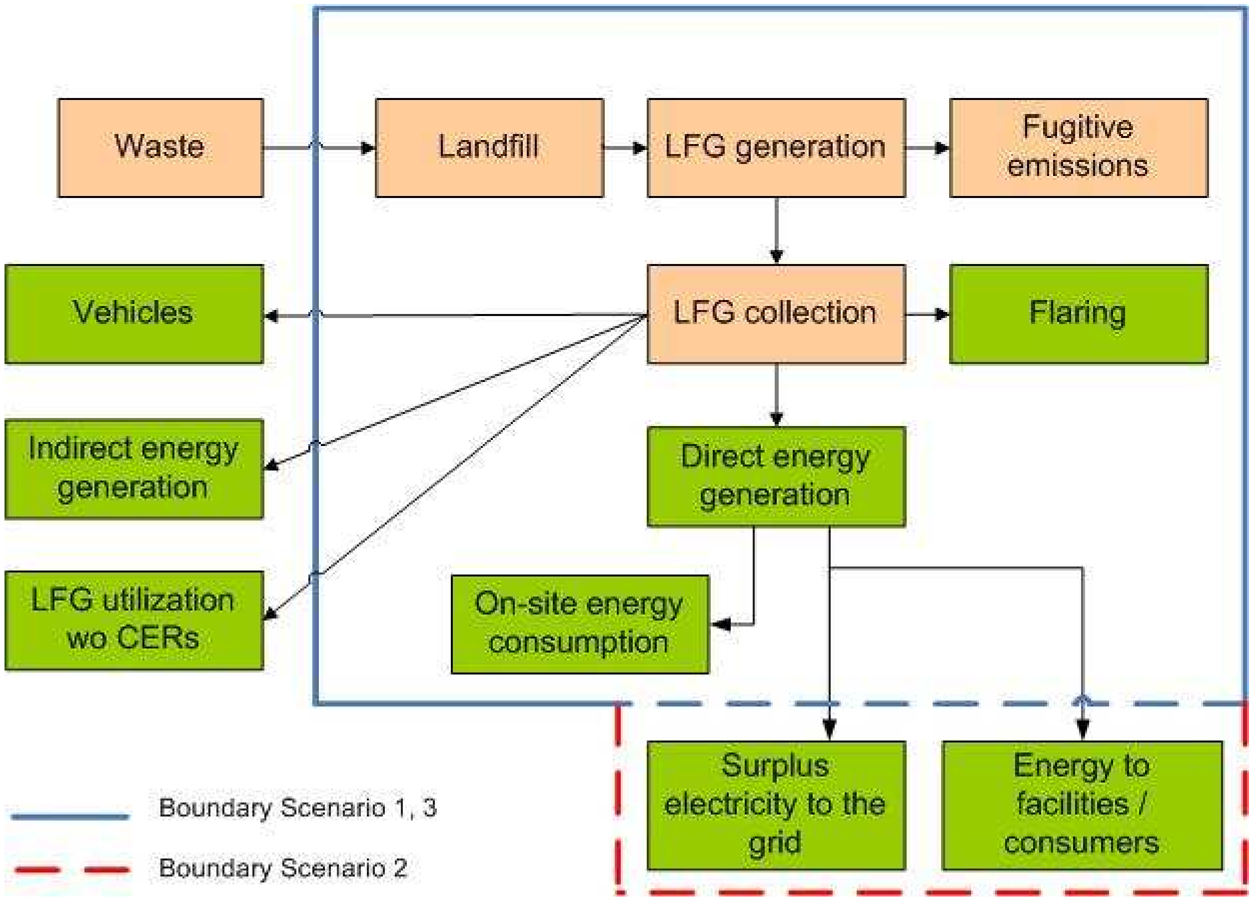

Figure 5: Project Boundaries in Scenarios and Options of LFG Utilization

According to the applied approved CDM methodologies the following gases and sources are included in the project boundary:

Table 6: Summary of Gases and Sources included in the Project Boundary of Scenarios 1 and 3

	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.

Table 7: 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.

E.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

For project activities that flare captured landfill gas and/or generate electricity, the baseline scenario is established in line with the approved baseline methodologies AMS-III.G and, as applicable, in combination with AMS-I.C and/or AMS-I.F.

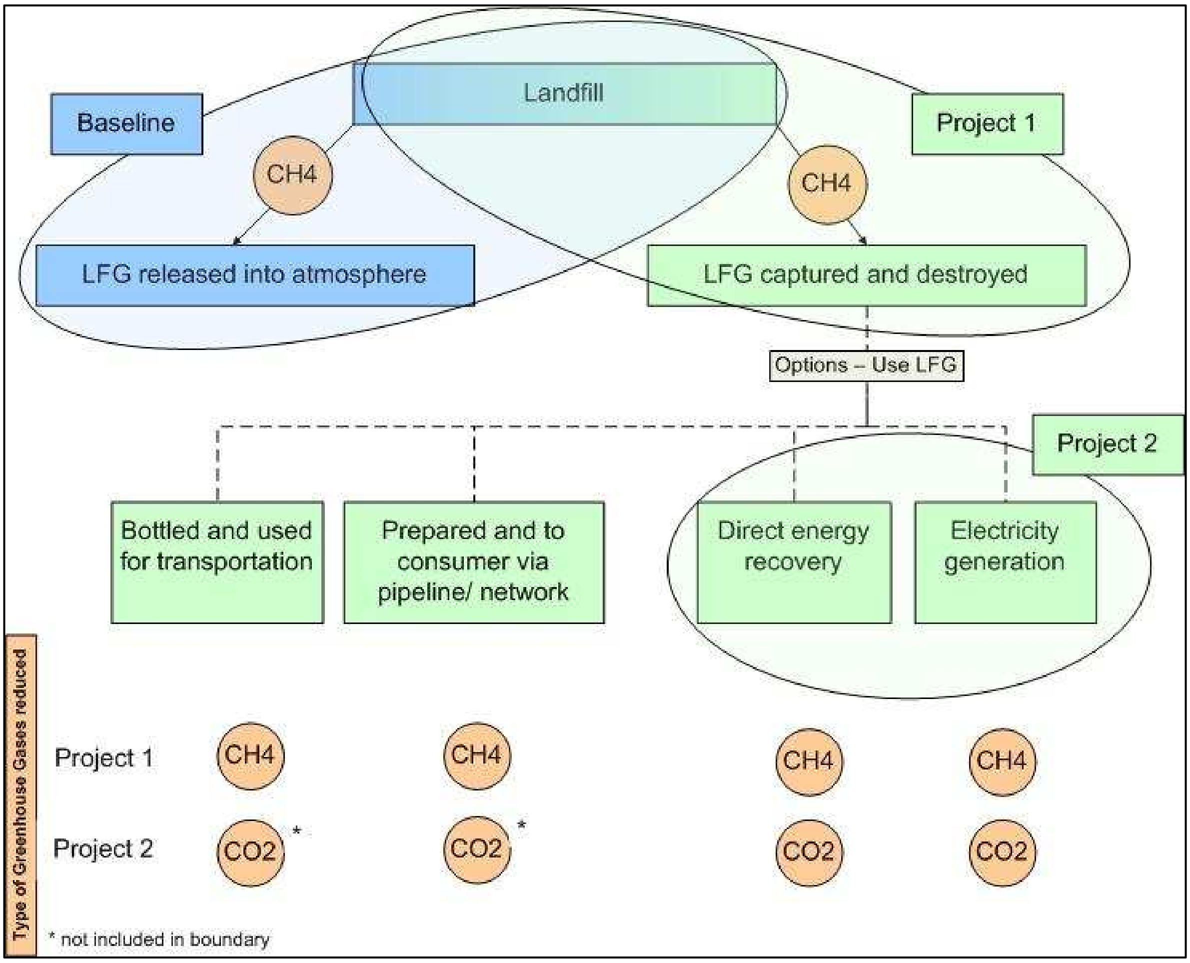

Figure 6: Baseline Scenario vs. Project Scenario (with project components "Project 1" and "Project 2")

As can be seen for the (essential) component "Project 1", according to the applied baseline and monitoring methodology AMS-III.G, the baseline is the partial or complete release of LFG to the atmosphere. LFG contains methane generated from the anaerobic decay of organic matter contained in the waste deposited at landfills.

In the proposed PoA, project activities are assumed to not destroy any LFG in the baseline, i.e. the baseline is the complete release of LFG to the atmosphere. Title F of the "Technical Regulation of the Drinking Water Sector and Basic Sanitation" (Spanish: Reglamento Tecnico para el Sector de Agua Potable y Saneamiento Básico, RAS 2000) applies to landfills stipulating the collection and passive flaring of landfill gas at the wellhead while control mechanisms are not defined. Passive flaring does not destruct any LFG, but only vents landfill gas from the solid waste disposal site to the atmosphere thereby avoiding risk of fire in the landfill body.

With respect to the (potential) second component "Project 2", the baseline is the continued consumption of fossil fuels for energy recovery for electricity and/or heat generation. This eventually includes the consumption of fossil fuels by grid connected power plants.

Further details on baseline determination can be found in section E.6.1 of this PoA-DD.

E.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the SSC-CPA being included as registered PoA (assessment and demonstration of additionality of SSC-CPA):

E.5.1. Assessment and demonstration of additionality for a typical SSC-CPA:

In the assessment of additionality of a CPA, an approach is taken that makes a difference between CPAs that will only be flaring of landfill gas through the entire crediting period of the CPA and CPAs that will utilize the captured landfill gas, be it only during a certain time span of the crediting period. Any utilization of landfill gas might potentially create revenues that might theoretically lead to a situation in which a positive NPV is achieved meaning that the project would not be additional according to the defined criteria. The approach is described in the following figure.

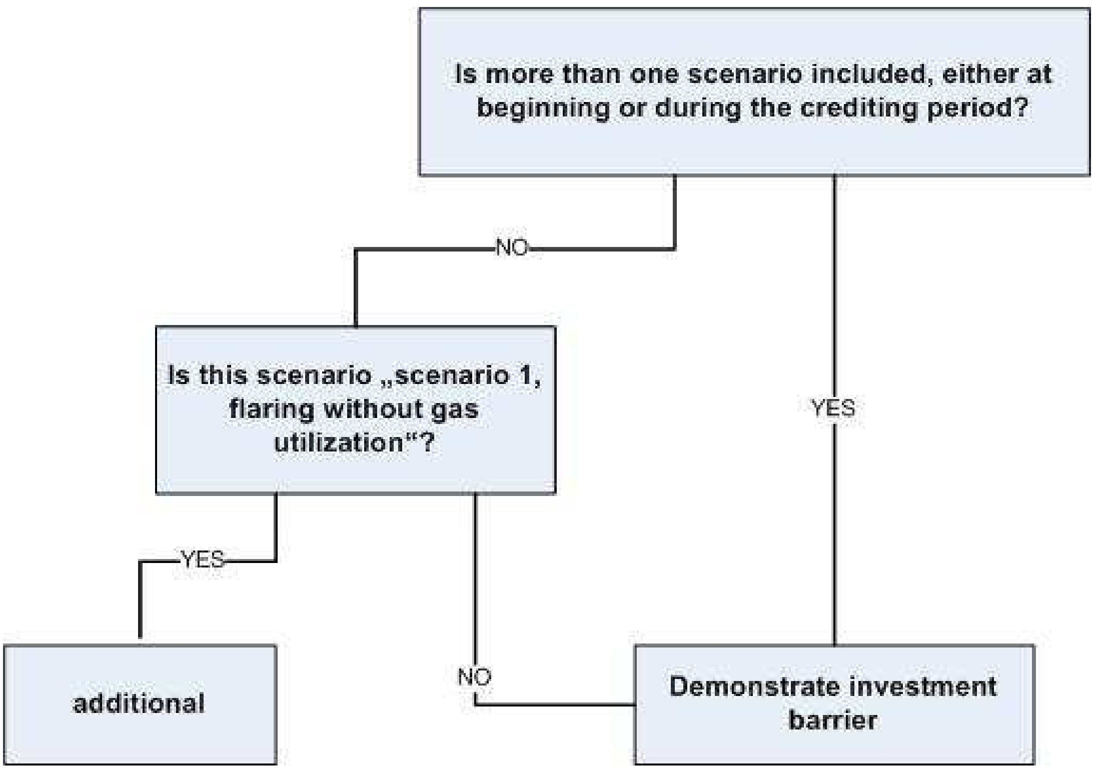

Figure 7: Approach for Assessment of Additionality of a CPA (schematic)

E.5.2. Key criteria and data for assessing additionality of a SSC-CPA:

Scenario	Criteria	
1	-	Any CPA implemented under the proposed PoA and implementing exclusively scenario 1 is additional (compare section A.4.3.)
2	A	An investment analysis has been applied as defined in section A.4.3. The analysis includes all forms of LFG utilization being operated by the CPA during the crediting period. The NPV without CER revenues is negative being a very conservative criterion.
	B	A sensitivity analysis has been applied with a variation of ±10% in main parameters whereby the NPV without CERs is negative in any case. This is very conservative.
3	A	An investment analysis has been applied as defined in section A.4.3. The analysis includes all forms of envisaged LFG utilization. If LFG is sold to third parties the sale revenues are included. CER revenues are not included. The NPV is negative being a very conservative criterion.
	B	A sensitivity analysis has been applied with a variation of ±10% in main parameters. CER revenues are not included. The NPV is negative in any case. This is very conservative.

E.6. Estimation of Emission reductions of a CPA:

E.6.1. Explanation of methodological choices, provided in the approved baseline and monitoring methodology applied, selected for a typical SSC-CPA:

BASELINE EMISSIONS

Scenarios 1, 2, 3 (in line with AMS-III.G):
Baseline: The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirement or legal regulations.

Project Activity: The project activity is the capture and destruction (by flaring or utilization) of LFG.

The calculation of the annual baseline emissions (BE_y) is as follows:

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

Where:

$BE_{CH4,SWDS,y}$ Methane emission potential of a solid waste disposal site in year *y* (tCO_2e)
$MD_{reg,y}$ Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year y (tCH_4)
GWP_{CH4} Global Warming Potential of methane (tCO_2e/tCH_4)

$MD_{reg,y}$: Neither national nor local safety requirements nor other legal regulations in the host country do stipulate the capture and destruction of methane emissions from landfills. Solely the passive venting of landfill gas to avoid landfill fires is stipulated. Passive venting, however, does not destruct any methane emissions to the atmosphere. Thus, all CPAs included into the PoA may assume a value of zero for $MD_{reg,y}$.

$BE_{CH4,SWDS,y}$: The estimation of the methane emission potential of a solid waste disposal site ($BE_{CH4,SWDS,y}$) will be according to the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site":

- Assuming a value of zero for the parameter *f* (fraction of methane captured at the SWDS and flared, combusted or used in another manner); and
- With the definition of year *x* as "the year since the landfill started receiving wastes, *x* runs from the first year of landfill operation (*x=1*) to the year for which emissions are calculated (*x=y*)".

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

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

Where:

$BE_{CH4,SWDS,y}$	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

The parameters φ, f, F, and DOC_f are fixed parameters (see next section of DD). The other parameters will be determined as follows:

f: The fraction of methane captured in the baseline and flared, combusted or used in another manner is set to zero according to § 8 of AMS-III.G. The fraction of methane captured and destroyed is accounted for with the parameter $MD_{reg,y}$.

OX: The oxidation factor assumes a value of either 0.0 or 0.1. For determining its value the type of cover of the solid waste disposal site in the project boundary will be assessed and categorized according to the „IPCC 2006 Guidelines for National Greenhouse Gas Inventories“. A value of 0.1 is used for managed landfills that are covered with oxidizing material and 0.0 for other cases.

MCF: The methane correction factor is selected from the following table according to the indicated criteria for each landfill in the project boundary of a CPA:

Table 8: Methane Correction Factor (MCF) for Solid Waste Disposal Sites

Value	Criterion
1.0	**Anaerobic managed solid waste disposal sites.** These must have controlled placement of waste (i.e. waste directed specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of waste.
0.5	**Semi-aerobic managed solid waste disposal sites.** These must have controlled placement of waste and will include all of the following structures for introducing air to the waste layers: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system;
0.8	**Unmanaged solid waste disposal sites – deep and/or with high water table.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 m and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste
0.4	**Unmanaged-shallow solid waste disposal sites.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 m.

Source: Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site

$W_{j,x}$: The amount of waste deposited shall be determined by sampling and the parameter $W_{j,x}$ shall thereby be calculated as follows:

$$W_{j,x} = W_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z}$$

Where:

W_x Total amount of organic waste prevented from disposal in year *x* (tons)

$p_{n,j,x}$ Weight fraction of the waste type *j* in the sample *n* collected during the year *x*

z Number of samples collected during the year *x*

DOC_j: The fraction of degradable organic carbon in waste type *j* is taken from the “2006 IPCC Guidelines for National Greenhouse Gas Inventories” distinguishing wet and dry waste. The respective values are copied below:

Table 7: DOC-Rates for Waste Types (Source: 2006 IPCC Guidelines) (in %)

Waste type *j*	**Wet waste**	**Dry waste**
Wood and wood products	43	50
Pulp, paper and cardboard (other than sludge)	40	44
Food, food waste, beverages and tobacco (other than sludge)	15	38
Textiles	24	30
Garden, yard and park waste	20	49
Glass, plastic, metal, other inert waste	0	0

Source: Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site

k_j: The decay rate k_j is taken from the "2006 IPCC Guidelines for National Greenhouse Gas Inventories" taking into account climate zone. The corresponding values are copied below:

Table 8: 2006 IPCC Guidelines Decay rates k for Waste Types

Waste type j	Boreal and Temperate (MAT≤20°C)		Tropical (MAT>20°C)	
	Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry (MAP≤1,000mm)	Wet (MAP> 1,000mm)
Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
Wood, wood products and straw	0.02	0.03	0.025	0.035
Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

MAT - mean annual temperature, MAP - Mean annual precipitation, PET - potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.
Source: Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site

Scenario 2a (in line with AMS-I.F):
Baseline: Baseline emissions for other systems are the product of amount electricity displaced with the electricity produced by the renewable generating unit and an emission factor.

Project Activity: The project activity is the installation of renewable energy generation units including renewable biomass that displaces electricity from an electricity distribution system. Co-generation units are not eligible. In the proposed PoA, co-generation units are considered in scenario 2c.

Calculation of baseline emissions for the year *y* (BE_y):

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

Where:

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 emission factor is calculated according to the origin of the displaced baseline electricity:

a) *Grid*: The emission factor is calculated as per the "Tool to calculate the Emission Factor for an electricity system". This procedure is in line with the procedure provided in AMS-I.D;
b) *Mini-grid*: The emission factor is calculated with the emission factors indicated in

Table I.F.1 for 100% fossil fuel operated mini-grids and else as weighted average emission factor as indicated in AMS-I.D;

c) *Captive power plant*: The emission factor is calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” for captive electricity systems.

Ad case a): The emission factor is calculated according to the “Tool to calculate the Emission Factor for an electricity system”. The Colombian Ministry for Mines and Energy, in its function as DNA of the Republic of Colombia, has been enacting the emission factor since 2010 with an annual update (Resolución 180947, June 4, 2010). The most recent available value is for 2010. This value is applied as the emission factor for the proposed PoA:

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

Ad case b): This case is excluded from the PoA according to the eligibility criteria.

Ad case c): As the captive power plant is not a co-generation plant, the emission factor is calculated according to Option B1, formula (4) of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. This formula is for captive power plants other than co-generation plants.

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

Where:

$FC_{n,i,y}$	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

Ad case a) and c): In case of a combination of case a) and case c), that means for project activities that displace grid electricity and fossil fuel fired on-site captive electricity, the baseline emission factor should reflect the emissions intensity of the grid and the captive power plant in the baseline scenario as weighted average. For new facilities, the most conservative (lowest) of the emission factor for the two power sources, grid electricity and captive electricity, should be used.

CPA activities that include a retrofit of an existing facility are eligible to participate in the PoA, if the retrofit activity involves a fuel switch from fossil fuels to renewable LFG.

Scenario 2b (in line with AMS-I.C):

Baseline: The baseline scenario is the situation in which the fuel consumption of the technology that would have been used in the absence of the project activity would be continued. The fuel consumption is multiplied by an emission factor to calculate the baseline emissions.

Project Activity: The project activity is the installation of renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. Co-generation units are eligible, but are considered under Scenario 2c in this proposed PoA.

For steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

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

Where:

$BE_{thermal,CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year *y* (tCO_2)
$EG_{thermal,y}$	The 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

The above calculation shall also be applied to project activities that seek to retrofit or modify an existing facility for the purpose of fuel switch from fossil fuels to biomass.

The baseline efficiency, for existing facilities with an operation history above three years, shall be calculated as the emissions from the production of steam/heat considering most recent historical records for at least the most recent three years. For existing facilities with a shorter operation history all historic data shall be applied. For other existing facilities parameters shall be determined based on a performance test/ measurement campaign. In the case of project activities that export to other facilities within the project boundary, historical data from the recipient plants is also required.

The baseline emission factor, for project activities implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, shall be 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.

CPA activities that include a retrofit of an existing facility are eligible to participate in the PoA, if the retrofit activity involves a fuel switch from fossil fuels to renewable LFG.

Scenario 2c (in line with AMS-I.C and AMS-I.F, as applicable):

Baseline: The baseline scenario is the situation in which the fuel consumption of the technology that would have been used in the absence of the project activity would be continued. The fuel consumption is multiplied by an emission factor to calculate the baseline emissions.

Project Activity: The project activity is the installation of renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. Co-generation units are eligible. CPA activities that include a retrofit of an existing facility are eligible to participate in the PoA, if the retrofit activity involves a fuel switch from fossil fuels to renewable LFG.

According to the methodology, the baseline scenario is one of the following (separate for thermal and electrical energy):

Table 9: Baseline Scenarios for Activities that Generate Electricity and Thermal Energy

Scen	Electrical Energy	Thermal Energy (heat/steam)
A	grid import	fossil fuel
B	fossil fuel	fossil fuel
C	grid import & fossil fuel	fossil fuel
D	cogeneration (fossil fuel)	cogeneration (fossil fuel)
E	grid import and/or fossil fuel	biomass
F	grid import and/or biomass	fossil fuel
G	cogeneration (biomass) (no export)	cogeneration (biomass) (no export)
H	co-firing of biomass & fossil fuels	co-firing of biomass & fossil fuels
I	grid import and/or cogeneration (biomass) (no export)	cogeneration (biomass) (no export) and/or biomass (no export)

Source: Own presentation according to AMS-I.C, version 19

With respect to the proposed PoA not all of these potential scenarios are considered. Baselines that involve a partial biomass baseline (for electricity and/or thermal energy generation) will not claim CERs as total emission reduction from this component is expected too small to justify transaction costs. So, scenarios E, F, G, H, and I are not eligible under the proposed PoA.

In the event of baseline scenarios A, B, C, or D being the applicable baseline scenario, the following considerations shall be made to estimate annual baseline emissions (BE_y):

Baseline emissions for electricity production

Case 1: Baseline is electricity generation in captive, fossil fuel fired plant(s):

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

Where:

$BE_{captelec,y}$	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

Case 2: Baseline is electricity import from the electricity grid:

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

Where:

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)

In line with § 20 of AMS-I.C, baseline emissions for supply of electricity to the grid are calculated as per the procedures detailed in AMS-I.F. This means the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" is to be applied. In line with the applicable Scenario A, provided by the tool, and the selected option 1, the emission factor is calculated according to the "Tool to calculate the Emission Factor for an electricity system". Thus:

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

Case 3: Baseline is export of electricity to the electricity grid:

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

Where:

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)

In line with § 20 of AMS-I.C, baseline emissions for displacement of electricity from the grid are calculated as per the procedures detailed in AMS-I.D. This methodology refers to the "Tool to calculate the Emission Factor for an electricity system". Thus:

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

Combination of Case 1, and Case 2 or Case 3: The baseline is the captive electricity generation and/or displacement of grid electricity import and/or supply of electricity to a grid. The emission factor should thus reflect both the emission intensity of the captive power plant and the grid.

- If annual electricity produced in the project activity is less than or equal to the sum of on-site captive generation and net grid import in average of the most recent three years, the emission factor shall be calculated as the weighted average of on-site captive electricity generation and the net grid electricity import in the baseline.
- If annual electricity produced in the project activity is greater than the sum of on-site captive generation and net grid import in average of the most recent three years, the lower of the two i.e. the emission factor of the grid or the emission factor of the baseline captive plant shall be used for the incremental generation.

For new facilities the lowest emission factor should be used.

Combination of Case 2 and Case 3: The baseline is electricity import from the grid or electricity export to the grid. Captive generation is thus not included. Thus § 25 of AMS-I.C is applicable stipulating the calculation of the emission factor as per the procedures detailed in AMS-I.D. Correspondingly, the emission factor is as per the ""Tool to calculate the Emission Factor for an electricity system". Thus:

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

Baseline emissions for steam/heat production

For steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

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

Where:

$BE_{thermal,CO_2,y}$	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,CO_2}	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

Baseline emissions for power and heat production

Scenario (D), Table 9, is the production of electricity and thermal energy (steam/heat) in a baseline cogeneration unit using fossil fuels. For the calculation of baseline emissions, the following equation shall be used:

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

Where:

$BE_{cogen,CO_2,y}$	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,CO_2}	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

Greenfield activities are excluded from the PoA if the baseline consists of cogeneration plants/units.

Total baseline emissions

Baseline emissions shall be calculated as the sum of baseline emissions from the production of electricity and the production of steam/heat considering most recent historical records. In doing so, the following criteria shall be applied:

The baseline efficiencies, for existing facilities with an operation history above three years, shall be calculated as the emissions from the production of steam/heat considering most recent historical records for at least the most recent three years. For existing facilities with a shorter operation history all historic data shall be applied. For other existing facilities parameters shall be determined based on a performance test/ measurement campaign. In the case of project activities that export to other facilities within the project boundary, historical data from the recipient plants is also required.

The baseline emission factors, for project activities implemented in existing facilities where the additionality is demonstrated based on a baseline scenario that is not the continuation of the current practice, shall be 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.

<u>PROJECT EMISSIONS</u>

<u>Scenarios 1, 2, 3 (in line with AMS-III.G):</u>

According to § 6 of AMS-III.G, project emissions consist 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.

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

Where:

$PE_{power,y}$	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)
$PE_{process,y}$	Emissions from the landfill gas upgrading process in the year *y* (determined by following the relevant procedures described in Annex 1 of AMS-III. H (tCO_2e)

In the sense of the proposed PoA, this means project emissions consist of the electricity consumption by the installed project facilities and the emission from flaring or combustion of the landfill gas stream. Project facilities will not consume fossil fuels and upgrading of landfill gas is not included in the project boundary.

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* (kg/h)
$\eta_{flare,h}$	Flare efficiency in hour *h* (ratio)
GWP_{CH4}	Global Warming Potential of methane (valid for the commitment period) (tCO_2e/tCH_4)

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.m³/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)

$$V_{n,o_2,h} = n_{o_2,h} * MV_n$$

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)
$FV_{RG,h}$	m³/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/m³	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).

<u>Scenario 2a (in line with AMS-I.F):</u>
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 (“Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”). 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

<u>Scenario 2b (in line with AMS-I.C):</u>
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.): The operation of heat generation equipment under the proposed PoA might be linked to the operation of auxiliary electronic equipment. The electricity consumption by this equipment will be monitored. 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.

<u>Scenario 2c (in line with AMS-I.C):</u>

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 renewable energy generation equipment under the proposed PoA will not be linked to the consumption of fossil fuels, e.g. for start-up of cogeneration units. The start-up of these facilities can be done with LFG since methane concentration is expected to be above 30%.

Ad ii.): The operation of renewable energy generation equipment under the proposed PoA might be 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.

<u>LEAKAGE EMISSIONS</u>

<u>Scenario 1, 2, 3:</u>

Leakage effects would have to be accounted for if the methane recovery technology would be transferred from another activity.

The proposed PoA will not lead to the transfer of equipment from another activity. This source of leakage emissions is thus not applicable.

<u>Scenario 2:</u>

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. Leakage emissions from the consumption of LFG are not occurring. Further, also the transportation of the LFG is not linked to leakage emissions (e.g.

from consumption of fossil fuels for long-distance transportation of wood chips). LFG can be considered a biomass residue. This source of leakage is thus not applicable.

The specific stipulations by AMS-I.F and AMS-I.C for project activities under a PoA have been taken into account.

EMISSION REDUCTION

In order to calculate total emission reduction the following stepwise approach shall be followed:

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).

Step 2: Add additional baseline emissions, project emissions, and leakage emissions for scenario 2. Calculate additional emissions reductions for scenario 2 according to the following formula:

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

Where:

$ER_{y,scen2}$	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)

Step 3: Sum $ER_{y,scen2}$ and $ER_{y,calculated}$ to calculate total emissions reductions as follows:

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

E.6.2. Equations, including fixed parametric values, to be used for calculation of emission reductions of a SSC-CPA:

In the host country there are neither contractual requirements nor local nor national mandatory regulations that force the destruction of methane from landfills, therefore $MD_{reg,y}$ is set to zero but will be reviewed accordingly in case there is change at the renewal of the crediting period of the PoA.

Table 10: Fixed Parametric Values

Scen	Parameter	Description	Unit	Value
All	f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner in the baseline. Assumed to be zero according to § 5, AMS-III.G, version 7	-	0.0
All	$MD_{reg,y}$	Amount of methane that would be captured and destroyed to comply with national or local safety requirements or legal regulations in the year *y*	tCH_4	0.0
All	φ	Model correction factor to account for uncertainties	-	0.9
All	GWP_{CH4}	Global Warming Potential of methane (GWP_{100}) during the first Kyoto commitment period	tCO_2e/tCH_4	21
All	F	Fraction of methane in the SWDS gas (volume fraction)	-	0.5
All	DOC_f	Fraction of degradable organic carbon (DOC) that can decompose	-	0.5
All	D_{CH4}	Methane density at standard temperature and pressure conditions	tCH_4/m^3CH_4	0.0007168
All	P_n	Atmospheric pressure at normal conditions	Pa	101,325
All	T_n	Temperature at normal conditions	K	273.15
All	R_u	Universal ideal gas constant	$Pa*m^3/kmol*K$	8,314.472
All	AM_j	Atomic mass of element *j*	kg/kmol	C: 12.00 O: 16.00 H: 1.01 N: 14.01
All	MM_i	Molecular mass of the residual gas component *i*	kg/kmol	CH_4: 16.04 CO: 28.01 CO_2: 44.01 O_2: 32.00 H_2: 2.02 N_2: 28.02
All	MV_n	Volume of one mole of any ideal gas at normal conditions	m^3/mol	22.414
All	MF_{O2}	Volumetric fraction of O_2 in the air	-	0.21
All	$\rho_{CH4,n}$	Density of methane at normal conditions	kg/m^3	0.716

E.6.3. Data and parameters that are to be reported in CDM-SSC-CPA-DD form:

All scenarios:

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)
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
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
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
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*
Source of data used:	Sampling
Justification of the choice of data or description of measurement methods and procedures actually applied :	Waste composition is determined through sampling once at the inclusion of the CPA into the PoA and, if wastes are deposited during the crediting period, also through sampling during the crediting period determining the parameters W_x, $p_{n,j,x}$ and z.
Any comment:	W_x: Total amount of organic waste $p_{n,j,x}$: Weight fraction of waste type *j* in the sample *n* collected during year *x* z: Number of samples collected during the year *x*

Data / Parameter:	**Rr**
Data unit:	Ratio
Description:	Recovery rate of the project's landfill gas capture system
Source of data used:	Own estimation by project participants.
Justification of the choice of data or description of measurement methods and procedures actually applied :	A value of up to 0.5 is regarded reasonable. Determined once at inclusion of CPA into PoA.
Any comment:	Only applied for the *ex-ante* estimation of emission reductions.

Scenario 2:

Data / Parameter:	$\mathbf{EG_{n,y}}$
Data unit:	MWh
Description:	Quantity of electricity generated in captive power plant in year *y*
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:	Only if energy from captive plants is displaced by the project activity (scenario

	2a or 2c)

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*
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:	Only if energy from captive plants is displaced by the project activity (scenario 2a or 2c)

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*
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:	Only if energy from captive plants is displaced by the project activity (scenario 2a or 2c)

Data / Parameter:	**$EF_{CO2,i,y}$**
Data unit:	tCO2/GJ
Description:	CO2 emission factor of fuel type *i* used during the year *y*
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:	Only if energy from captive plants is displaced by the project activity (scenario 2a or 2c)

Data / Parameter:	$\mathbf{EF_{FF,CO2}}$ (scenario 2b or 2c), $\mathbf{EF_{BL,FF,CO2}}$ (scenario 2c)
Data unit:	tCO2/TJ
Description:	CO2 emission factor of the fossil fuel that would have been used in the baseline
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:	
Any comment:	Relevant, if thermal energy generation by the project activity displaces fossil fuel based thermal energy generation.

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
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).

E.7. Application of the monitoring methodology and description of the monitoring plan:

E.7.1. Data and parameters to be monitored by each SSC-CPA:

All scenarios:

Data / Parameter:	$\mathbf{LFG_{i,y}}$
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	The flow meter will be subject to a regular maintenance according to

be applied:	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:	**$fv_{i,h}$**
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 measurement methods and procedures to be applied:	Ensure that the same basis (dry basis) is considered here and for $FV_{RG,h}$
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 $LFG_{i,y}$.

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:	

Scenario 2:

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:	CO2 emission factor of the grid in the year *y*
Source of data used:	Calculated or taken from latest available version of the updated “Resolución 180947” according to case
Description of measurement methods and procedures to be applied:	Case a): Grid electricity displacement: Take lasted available value of the updated “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

All scenarios

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.

Scenario 2

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.

E.7.2. Description of the monitoring plan for a SSC-CPA:

The CPAs to be included in the proposed PoA will be monitored according to the following structure:

The CME takes over responsibilities of the CME and the project implementer at a time. The CME is CarbonBW Colombia S.A.S. The team of CarbonBW Colombia is small but experienced with CDM activities including all steps from project identification, via implementation, up to monitoring of operation.

Section	**Position**	**Responsibilities/ Competencies**
CME	Head	-Crosschecks inclusion of CPAs according to pre-assessment of fulfilment of eligibility criteria. -Crosschecks appropriateness of technical design. -Organizes training for personnel on aspects of the monitoring plan

		relating to CDM (inclusion of CPAs, handling of monitoring equipment, failure of equipment). -Submission of documents to DOE requesting inclusion of the CPA into the PoA.
		Competencies: CDM rules and regulations, contracts (e.g. gas utilization concessions), management and coordination, CDM landfill activities.
CPA Expansion	Head	-Coordination with Head "CPA Development" to ensure the technical design of the CPAs fits the eligibility criteria stipulated in the PoA-DD according to applied methodology/ies. -Verification that eligibility criteria are met by CPAs (as prepared by Executive "CPA Expansion"). -Submit data on CPAs and assessment of eligibility criteria for each CPA to Head of CME for crosscheck. -Verifies the fulfilment of methodological eligibility criteria. -Gives instructions on the conduction of the stakeholder consultation. -Maintains register of CPAs and CPA-specific folders (containing all documents related to eligibility and to monitoring). -Estimates emission reduction and other main design parameters together with Head "CME" and Head "CPA Development".
		Competencies: CDM cycle including stakeholder consultation, CDM methodologies, PoA-design and management/coordination experience, landfill regulations in Colombia.
	Executive	-Verifies the completeness of documents to be signed by landfill owner. -Verifies the completeness of other documents. -Verifies coordinates of location of project site (landfill) (unique identification). -Verifies that the landfill site is not part of another CDM activity (registered or requesting registration) (UNFCCC homepage).
		Competencies: Landfill regulations in Colombia, environmental law in Colombia, CDM
CPA Development	Head	-Engineering, planning, monitoring equipment, technical specifications -Close coordination with Head "CME" on design requirements -Close coordination with Head "CPA Operation" on monitoring requirements. (maybe same person as Head "CPA Operation")
		Competencies: Engineering of landfill activities (landfill gas capture and destruction), landfill gas utilization, operation of landfill gas equipment, monitoring equipment for landfill activities.
CPA Operation	Head	-Training regarding safety regulations (due to operation of project activity). -Instructs personnel on adequate reactions in case of failure of (monitoring) equipment. -Operation and maintenance of web-based record and control system of monitoring equipment. -Verifies that the record system collects specific data for each individual CPA (and backup system on external server). -Verifies that records are kept for the minimum period specified in the monitoring section of the PoA-DD.

		-Assigns unique identification number for each new CPA (candidate) (ID number).
		Competencies: Extensive IT-knowledge, web-based record and control systems
	Executive	-Updates parameters: emission factors, IPCC default values (e.g. GWP_{CH4}). -Functionality of monitoring equipment. -Recording of monitoring data. -Organizes calibration of monitoring equipment. -Organizes repair/maintenance of equipment. -Operation and maintenance of web-based record and control system of monitoring equipment. -Produces the monitoring protocols.
		Competencies: Extensive IT-knowledge, technical knowledge (monitoring equipment).

E.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completion of the baseline study: 10/10/2011

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Annex 1

CONTACT INFORMATION ON COORDINATING/MANAGING ENTITY and PARTICIPANTS IN THE PROGRAMME of ACTIVITIES

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION

Annex 4

MONITORING INFORMATION

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