Draft baseline and monitoring methodology AM00XX

"Methodology for collection, processing and supply of biogas to end-users for production of heat"

I. SOURCE AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the following approved baseline and monitoring methodologies and proposed new methodologies:

- NM0248 "Biogenic methane use as energy source replacing fossil fuel and/or grid electricity" and its underlying project activity "Project for useful use of landfill gas actually being flared substituting natural gas" prepared by Ecoinvest Carbon.

This methodology also refers to the latest approved versions of the following tools:

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion;
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption;
- Tool to determine project emissions from flaring gases containing methane;
- Tool for the demonstration and assessment of additionality;[1]

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

Definitions

For the purpose of this methodology, the following definitions apply:

Biogas is a mixture of biogenic gases composed mainly of methane and carbon dioxide produced from the decomposition of waste organic matter under anaerobic conditions.

Waste organic matter is organic matter from either vegetable or animal biomass but not from mineral (fossil) sources.

Biogas producing site is the site where the biogas is generated from the decomposition of organic matter. Biogas producing sites are either landfills or wastewater treatment plants[2]. An existing biogas producing site is a biogas producing site which was generating biogas before the implementation of the project activity.

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[1] Please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

[2] If project participants wish to apply this methodology to other types of biogas producing sites (e.g. biodigesters), they should submit a request for revision including procedures to ensure that waste organic matter is not diverted from useful purposes to produce biogas in the project activity (e.g. waste cooking oil diverted from biodiesel production to biogas production). Otherwise, leakage emissions from use of alternative fuels or feedstocks at the original user of the waste organic matter would need to be considered. Similarly, if the biogas is not generated from wastes but from feedstocks that are cultivated for the purpose of producing biogas, the emissions from the cultivation of the feedstocks would need to be estimated if significant.

Biogas processing facility is the facility which collects biogas from one or several biogas producing sites, processes and upgrades the biogas for the purpose of supplying it to end-users.

Processed biogas is the methane rich gas obtained from the processing and upgrading of biogas at the biogas processing facility.

End-user is the facility to which the processed biogas is transported and in which the processed biogas is used to produce heat. An existing end-user is an end-user which was producing heat with other fuels than biogas before the implementation of the project activity.

Heat is the heat contained in the following heat carriers: steam, hot water or thermic fluids. Other forms of heat carriers, such as air, are excluded from this methodology.

Heat generation equipment is equipment in which fuels (e.g. processed biogas, fossil fuels, etc.) are combusted for the purpose of generating heat. The heat is used in industrial, commercial or residential applications for processing or heating purposes other than for generation of electric power or mechanical energy.

Applicability

The methodology is applicable to project activities that collect biogas from one or several biogas producing site(s), process and upgrade the biogas in a new biogas processing facility which is constructed and operated as part of the project activity, and supply the processed biogas to end-user(s). The end-user(s) will use the processed biogas to produce heat[3] in heat generation equipments.

The methodology is applicable under the following conditions:

- The biogas is obtained from one or several existing[4] biogas producing site(s). All biogas producing sites from which biogas is collected under the project activity have to be identified *ex-ante*, at the validation stage;[5]
- The biogas from the biogas producing sites was either vented or flared prior to implementation of the project activity. Project participants should demonstrate this through documented evidence. If any portion of the biogas from these sites was not vented or flared prior to implementation of the project activity (e.g. was used for energy purposes), the methodology is not applicable;
- The processed biogas is supplied to existing end-users, which use the biogas in the heat generation equipment. All heat generation equipments included in the project activity have to be identified *ex-ante*, at the validation stage;[6]

[3] If project participants wish to apply this methodology to electricity production at the end-users, they should propose a request for revision to this methodology including procedures to select the baseline scenario, assess additionality and calculate emissions reductions for electricity generation, amending applicability conditions and monitoring procedures accordingly.

[4] If project participants wish to apply this methodology to new biogas producing sites which can be identified *ex-ante*, they should propose a request for revision to this methodology including procedures to select the baseline scenario for the new biogas producing sites and amend applicability conditions and emissions calculations as applicable.

[5] After validation, additional biogas producing sites cannot be included because a specific baseline scenarios would have to be identified for theses sites. However, this is not possible for a registered project activity. In cases where the sites can only be identified after validation, the methodology may be applied under a programme of activities.

[6] After validation, additional end-users cannot be included because a specific baseline scenarios would have to be identifed for these end-users. However, this is not possible for a registered project activity. In such cases, the methodology may be applied under a programme of activities.

- The end-users were using only fossil fuels at on-site heat generation equipments to meet their heat demands prior to implementation of the project activity. The project participants should demonstrate this through documented evidence. In case any heat generation equipment has used any renewable sources of energy prior to the implementation of the project activity, the methodology is not applicable;
- The heat produced by the heat generation equipment at the end-user(s) is totally used on-site.
- Under the project activity, the end-user(s) can use fossil fuels together with processed biogas from the biogas processing facility;
- The existing heat generation equipment may be modified in order to enable the use of processed biogas;
- The supply of processed biogas to the end-user(s) does not result in an increase in their heat generation capacity;
- Any transportation of biogas or processed biogas occurs only through dedicated pipelines or by road vehicles. This includes transportation of biogas from the biogas producing sites to the biogas processing facility and transportation of processed biogas from the biogas processing facility to the end-users. The biogas from the biogas producing sites is not mixed with biogas from sites that are not part of the project activity or with other gases (e.g. natural gas). The processed biogas from the project biogas processing facility is not mixed with biogas from other biogas processing facilities or with other gases (e.g. natural gas);
- The methodology cannot be used if the end-users are the project participants.[7] The project participant should ensure through a contractual agreement with the end-user(s) that the end-user(s) do not claim CERs from using the biogas.

In addition, the applicability conditions included in the tools referred to above apply.

Finally, this methodology is only applicable if the most plausible baseline scenario as determined by the below "Procedure for the identification of the most plausible baseline scenario and assessment of additionality" is, for the biogas producing sites and for the biogas processing facility, the combination of two scenarios:

B1: The biogas would have been vented or flared, but not used for energy purposes or as feedstock

and

F1: The biogas processing facility would not be constructed and the transportation infrastructure for the biogas and the processed biogas would not be established,

and for the end-users:

- The heat generated with processed biogas at the end-user(s) would be generated at on-site heat generation equipment using only fossil fuels and not renewable sources of energy.

[7] If end-users wish to use this methodology, they should submit a request for revision adapting the procedures to assess additionality and select the baseline scenario to end-users.

II. BASELINE METHODOLOGY

Project boundary

The spatial extent of the project boundary encompasses:

- The biogas producing site(s);
- The biogas collection, pre-processing (if any) and transport system from the biogas producing site(s) to the biogas processing facility;
- The biogas processing facility;
- The processed biogas transport system from the biogas processing facility to the end-user(s);
- The end-user(s).

The emission sources included in or excluded from the project boundary are described in Table 1.

Table 1: Emissions sources included in or excluded from the project boundary:

	Source	Gas	Included?	Justification / Explanation
Baseline	Combustion of fossil fuels to produce heat at end-user(s)	CO_2	Yes	Main emission source.
		CH_4	No	Emissions are considered negligible.
		N_2O	No	Emissions are considered negligible.
Project Activity	Emissions due to electricity consumption at the biogas producing site(s), the biogas processing site and at the site of the end-user(s)	CO_2	Yes	Main emission source.
		CH_4	No	Emissions are considered negligible.
		N_2O	No	Emissions are considered negligible.
	Emissions due to fossil fuels consumption at the biogas producing site(s), the biogas processing site and the site of the end-user(s)	CO_2	Yes	Main emission source.
		CH_4	No	Emissions are considered negligible.
		N_2O	No	Emissions are considered negligible.
	Emissions from biogas emitted to the atmosphere, in the form of CH_4, before reaching the end-users (leaks, venting, flaring and dissolved in wastewater)	CO_2	No	Emissions are considered negligible.
		CH_4	Yes	Main emission source.
		N_2O	No	Emissions are considered negligible.
	Emissions from the use of fossil fuels for	CO_2	Yes	Main emission source.

	the transportation of processed biogas to the end-user(s)	CH_4	No	Emissions are considered negligible.
		N_2O	No	Emissions are considered negligible.

Procedure for the identification of the most plausible baseline scenario and assessment of additionality

Step 1: Select the most plausible baseline scenario for the end-users

In order to confirm that the continuation of the current practice of using only fossil fuels at on-site heat generation equipments to meet the heat demand(s) at the end-user(s) is the most plausible baseline scenario project participants shall:

(a) Provide documentation and demonstrate that each end user included in the project was using only fossil fuels and no renewable sources of energy to meet the heat demand(s) for the last 3 years;

(b) Provide written confirmation from end-users that they do not plan to use renewable sources of energy to meet the heat demand(s) along the crediting period and will continue to use fossil fuels;

(c) Provide documentation that the use of fossil fuel is in compliance with all mandatory applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions. This does not include national and local policies that do not have a legally-binding status.

The continuation of the current practice of using fossil fuels to meet the heat demand(s) can only be considered the most plausible baseline scenario if all three conditions above are met.

Step 2: Identify technically feasible alternative scenarios for the biogas producing sites and for the biogas processing facility

This step aims at identifying the most plausible baseline scenario for the biogas producing sites and for the biogas processing facility and the transportation infrastructure.

Step 2.1: Identification of alternative baseline scenarios

At least the following alternative baseline scenarios should be considered for the biogas producing sites:

B1: The biogas would have been vented or flared, but not used for energy purposes or as feedstock;

B2: The biogas would have been captured and used for energy purposes, on-site or off-site;

B3: The biogas would have been captured and used as feedstock, on-site or off-site;

B4 The biogas would have been partly vented or flared and partly captured and used for energy purposes and/or as feedstock, on-site or off-site;

B5: The biogas would not be produced, e.g. the organic sources would be treated in a different manner.

At least the following alternative baseline scenarios should be considered for the biogas processing facility and the transportation infrastructure:

F1: The biogas processing facility would not be constructed and the transportation infrastructure for the biogas and the processed biogas would not be established;

F2: The biogas processing facility would be constructed and the transportation infrastructure for the biogas and the processed biogas would be established.

If one or more scenarios are excluded, an appropriate explanation and documentation to support the exclusion of such scenario shall be provided.

Project participants should identify all realistic and credible baseline scenarios for the biogas producing sites (B1 to B5) and the biogas processing facility and the transportation infrastructure (F1 to F2). Realistic combinations of these should be considered as possible alternative scenarios to the proposed project activity in the following steps.

Step 3: Eliminate baseline alternatives that do not comply with legal or regulatory requirements

The baseline alternatives shall be in compliance with all applicable legal and regulatory requirements, even if these laws and regulations refer to objectives other than GHG reductions (CH_4, CO_2, etc.). National and local policies that do not have legally-binding status are excluded from this step. Eliminate all baseline alternatives that are not in compliance with the legal and regulatory requirements of the Host country or respective region.

If an alternative does not comply with all applicable legislation and regulations, then show, based on an examination of the current practice in the host country or region in which the law or regulation applies, that those applicable legal or regulatory requirements are systematically not enforced and non-compliance with those requirements is widely spread in the country. If this cannot be shown, alternative must be eliminated from further consideration.

If the proposed project activity remains the only alternative that complies with all regulations, then the proposed project activity is the baseline scenario.

Step 4: Eliminate baseline alternatives that face prohibitive barriers

Step 4.1: Identify potential barriers

Based on the alternatives that are technically feasible and in compliance with all legal and regulatory requirements, the project participant should establish a complete list of barriers preventing alternatives from being implemented in the absence of the CDM revenues. These barriers may include, among others:

- Investment barriers, *inter alia*:
    - Debt funding is not available for this type of a project activity;
    - Domestic or international capital markets are not accessible due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented.
- Technological barriers, *inter alia*:
    - Technical and operational risks of implementing the alternatives;
    - Non-availability of the respective technology;
    - Non-availability of the respective fuel or resources;
    - Lack of infrastructure for implementation of the technology;

  - Lack of skilled and/or properly trained labour to operate and maintain the technology;
  - Lack of demand for the useful product, outcome or effect of the alternative scenario.

- Barriers due to prevailing practice, *inter alia*:

  - The project activity is the "first of its kind". Currently no other project activity of this type is operational in the host country or region.

Provide transparent and documented evidence, and offer conservative interpretations of this documented evidence, as to how it demonstrates the existence and significance of the identified barriers. The type of evidence should at least include one the following:

(a) Relevant legislation, regulatory information or industry norms;
(b) Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, etc;
(c) Relevant statistical data from national or international statistics;
(d) Documentation of relevant market data (e.g. market prices, tariffs, rules);
(e) Written documentation from the company or institution developing or implementing the CDM project activity or the CDM project developer, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, etc;
(f) Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar previous project implementations;
(g) Written documentation of independent expert judgements from industry, educational institutions (e.g. universities, technical schools, and training centres), industry associations and others.

Step 4.2: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed CDM project activity)

If any of the baseline scenario alternatives face barriers that would prohibit them from being implemented, then these should be eliminated.

- If there is only one alternative scenario that is not prevented by any barrier, and if this alternative is the proposed project activity undertaken without being registered as a CDM project activity, then the project activity is not additional;
- If there is only one alternative scenario that is not prevented by any barrier, and if this alternative is not the proposed project activity undertaken without being registered as a CDM project activity, then this alternative scenario is identified as the baseline scenario. Explain – using qualitative or quantitative arguments – how the registration of the CDM project activity will alleviate the barriers that prevent the proposed project activity from occurring in the absence of the CDM. If the CDM alleviates the identified barriers that prevent the proposed project activity from occurring, proceed to Step 5, otherwise the project activity is not additional;
- If there are still several alternative scenarios remaining, including the proposed project activity undertaken without being registered as a CDM project activity, proceed to Step 4 (investment analysis);
- If there are still several alternative scenarios remaining, but which do not include the proposed project activity undertaken without being registered as a CDM project activity, explain – using qualitative or quantitative arguments – how the registration of the CDM project activity will alleviate the barriers that prevent the proposed project activity from occurring in the absence of the CDM. If the CDM alleviates the identified barriers that prevent the proposed project activity from occurring, project participants may choose to either:

Option 1: Go to Step 5 (investment analysis); or
Option 2: Identify the alternative with the lowest emissions (i.e. the most conservative) as the baseline scenario, and proceed to Step 6.

Step 5: Identify the economically most attractive baseline scenario alternative

This step serves to determine which of the alternative scenarios remaining after Step 4 is the most economically or financially attractive. For this purpose, an investment comparison analysis is conducted for the remaining alternative scenarios.

Identify the financial indicator, such as IRR, NPV, cost benefit ratio, or unit cost of service (e.g., levelized cost of electricity production in $/kWh) most suitable for the project type and the decision-making context.

Calculate the financial indicator for all alternatives remaining after Step 4 Include all relevant costs (including, for example, the investment cost, fuel costs and operation and maintenance costs), and revenues (including subsidies/fiscal incentives,[8] ODA, etc. where applicable), and, as appropriate, non-market costs and benefits in the case of public investors. The investment analysis should cover all costs and revenues of the alternative scenarios for both the operator of the biogas producing sites and operator of the biogas processing facility and the transportation infrastructure.

The investment analysis should be presented in a transparent manner and all the relevant assumptions should be provided in the CDM-PDD, so that a reader can reproduce the analysis and obtain the same results. Critical techno-economic parameters and assumptions (such as capital costs, fuel price projections, lifetimes, the load factor of the biogas processing plant and discount rate or cost of capital) should be clearly presented. Justify and/or cite assumptions in a manner that can be validated by the DOE. In calculating the financial indicator, the risks of the alternatives can be included through the cash flow pattern, subject to project-specific expectations and assumptions (e.g. insurance premiums can be used in the calculation to reflect specific risk equivalents). Where assumptions, input data, and data sources for the investment analysis differ across the project activity and its alternatives, differences should be well substantiated.

The price of the processed biogas, as agreed in biogas supply contracts between the project participant and the end-user(s) should be used in the calculation. For this purpose, the DOE should validate that the price assumed in the calculation is consistent with the contractual arrangements between the project participant and the end-user(s). Moreover, the DOE should validate that the price is within a realistic and plausible range, taking into account the composition of the gas (e.g. the price per net calorific value should by no means be higher than the price for the natural gas).

The CDM-PDD submitted for validation shall present a clear comparison of the financial indicator for all scenario alternatives. The baseline scenario alternative that has the best indicator can be pre-selected as the most plausible baseline scenario; then a sensitivity analysis shall be performed for all alternatives. The range of the sensitivity analysis should cover, in a realistic way, the possible variations of all key parameters that are related to the analysis and that could change over the crediting period.

A sensitivity analysis shall be performed for all alternatives, to confirm that the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions (e.g. fuel prices and the load factor). The investment analysis provides a valid argument in selecting the baseline scenario only if it consistently supports (for a realistic range of assumptions) the conclusion that the pre-selected baseline scenario is likely to remain the most economically and/or financially attractive.

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[8] Note the guidance by EB 22 on national and/or sectoral policies and regulations.

If sensitivity analysis confirms the result, then select the most economically attractive alternative as the most plausible baseline scenario. In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with the lowest emission rate among the alternatives that are the most financially and/or economically attractive.

If the emission rate of the selected baseline scenario is clearly below that of the project activity, then the project activity should not be considered to yield emission reductions, and this methodology cannot be applied.

Step 6: Demonstration of additionality

The assessment and demonstration of additionality comprises the following steps:

Step 6.1: Benchmark investment analysis

Demonstrate that the proposed project activity is unlikely to be financially attractive by applying Sub-steps 2b (Option III: Apply benchmark analysis), Sub-step 2c (Calculation and comparison of financial indicators), and 2d (Sensitivity Analysis) of the latest approved version of the "Tool for the demonstration and assessment of additionality". The investment analysis should cover all costs and revenues of the alternative scenarios for both the operator of the biogas producing sites and operator of the biogas processing facility and the transportation infrastructure. All relevant guidance provided in step 5 should be applied respectively.

Step 6.2: Common practice analysis

Demonstrate that the project activity is not common practice in the Host country and sector by applying Step 4 (common practice analysis) of the latest approved version of the "Tool for the demonstration and assessment of additionality".

If both steps 6.1 and 6.2 above are satisfied, the proposed CDM project activity is additional.

Baseline emissions

Baseline emissions include only CO_2 emissions from fossil fuels that would be used by the end-user(s) to produce heat in heat generation equipment(s). Baseline emissions are calculated based on the quantity of processed biogas supplied to each heat generation equipment, the fossil fuel type that would be fired in the absence of the project, and taking into account differences in the efficiency of the heat generation equipment in the project and in the baseline, as follows:

$$BE_y = \sum_i \left(BG_{i,y} \cdot NCV_{BG,y} \cdot \frac{\eta_{i,y}}{\eta_{i,BL}} \cdot EF_{i,BL} \right) \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2)
$BG_{i,y}$	=	Amount of processed biogas supplied to heat generation equipment i in year *y* (mass or volume units)
$NCV_{BG,y}$	=	Average net calorific value of the processed biogas in year *y* (TJ/mass or volume units)
$\eta_{i,y}$	=	Efficiency of biogas use in the heat generation equipment i in year *y* (dimensionless)
$\eta_{i,BL}$	=	Efficiency of the heat generation equipment that would have been used in the baseline instead of the heat generation equipment i (dimensionless)
$EF_{i,BL}$	=	Emission factor of the fossil fuel that would have been used instead of the biogas in heat generation equipment i in the baseline (tCO_2/TJ)

i = Each heat generation equipment at each end-user supplied with processed biogas
y = Year of the crediting period

Calculation of ratio of efficiencies ($\eta_{i,y} / \eta_{i,BL}$)

Project participants may choose one of the following options to determine the ratio of the efficiencies ($\eta_{i,y} / \eta_{i,BL}$):

Option A: Use $\eta_{i,y} / \eta_{i,BL}$ = 0.9 as a conservative approach (no monitoring of $\eta_{i,y}$ is required).

Option B: Use $\eta_{i,y} / \eta_{i,BL}$ = 1.0 if the processed biogas has the same or better quality as natural gas (the net calorific value of the processed biogas should be within the range of natural gas supplied to end-users in the region).

Option C: Follow the procedure below:

Calculation of $\eta_{i,y}$

If the heat generation equipment is a boiler producing steam, the efficiency ($\eta_{i,y}$) should be calculated as:

$$\eta_{i,y} = \frac{HG_{i,y} \cdot \left(HS_{i,y} - HW_{i,y}\right)}{BG_{i,y} \cdot NCV_{BG,y} + \sum_k \left(FF_{k,i,y} \cdot NCV_{k,i,y}\right)} \quad \textbf{(2)}$$

Where:

$\eta_{i,y}$ = Efficiency of biogas use in the boiler *i* in year *y* (dimensionless)
$HG_{i,y}$ = Amount of steam produced in the boiler *i* in year *y* (tonnes of steam)
$HS_{i,y}$ = Average specific enthalpy of the steam produced in the boiler *i* in year *y* (TJ/tonnes of steam), dependent on the average temperature ($TS_{i,y}$) and pressure ($PS_{i,y}$) of the steam during year *y*
$HW_{i,y}$ = Average specific enthalpy of the feedwater used in the boiler *i* in year *y* (TJ/tonnes of steam), dependent on the average temperature ($TW_{i,y}$) and pressure ($PW_{i,y}$) of the feedwater during year *y*
$BG_{i,y}$ = Amount of biogas supplied to the boiler *i* in year *y* (mass or volume units)
$NCV_{BG,y}$ = Average net calorific value of the processed biogas in year *y* (TJ/mass or volume units)
$FF_{k,i,y}$ = Amount of fossil fuel *k* used in the boiler *i* in year *y* (mass or volume units), if any
$NCV_{k,i,y}$ = Average net calorific value for the fossil fuel *k* used in the boiler *i* in year *y* (TJ/mass or volume units)
k = Fossil fuel type used in the project boiler *i*
i = Each boiler at each end-user supplied with processed biogas
y = Year of the crediting period

If the heat generation equipment is another heat generation equipment than a boiler, the efficiency of biogas use ($\eta_{i,y}$) should be calculated as:

$$\eta_{i,y} = \frac{HG_{i,y}}{BG_{i,y} \cdot NCV_{BG,y} + \sum_k \left(FF_{k,i,y} \cdot NCV_{k,i,y}\right)} \quad \textbf{(3)}$$

Where:

$\eta_{i,y}$	=	Efficiency of biogas use in the heat generation equipment *i* in year *y* (dimensionless).
$HG_{i,y}$	=	Amount of heat produced in the heat generation equipment *i* in year *y* (TJ)
$BG_{i,y}$	=	Amount of processed biogas supplied to the heat generation equipment *i* in year *y* (mass or volume units)
$NCV_{BG,y}$	=	Average net calorific value of the processed biogas in year *y* (TJ/mass or volume units)
$FF_{k,i,y}$	=	Amount of fossil fuel *k* used in the heat generation equipment *i* in year *y* (mass or volume units), if any
$NCV_{k,i,y}$	=	Average net calorific value for the fossil fuel *k* used in the heat generation equipment *i* in year *y* (TJ/mass or volume units)
k	=	Fossil fuel type used in the heat generation equipment *i*
i	=	Each heat generation equipment at each end-user supplied with processed biogas.
y	=	Year of the crediting period

Calculation of $\eta_{i,BL}$

The efficiency of the heat generation equipment that would have been used in the baseline instead of the heat generation equipment *i* ($\eta_{i,BL}$), is calculated as:

Option A: Use a default conservative value equal to 1.

Option B: Use a default conservative value obtained from the manufacture's databook, taking the highest possible efficiency under optimal operational conditions.

Option C: Use the average heat generation efficiency of the heat generation equipment *i*, calculated over the most recent three years prior to the implementation of the project activity (if three years data is not available, either Option A or B should be used). If the heat generation equipment is a boiler producing steam, the efficiency ($\eta_{i,BL}$) should be calculated as:

$$\eta_{i,BL} = \sum_{n=1}^{3} \frac{1}{3} \cdot \left[\frac{HG_{i,n} \cdot \left(HS_{i,n} - HW_{i,n} \right)}{\sum_{k} \left(FF_{k,i,n} \cdot NCV_{k,i,n} \right)} \right] \quad \textbf{(4)}$$

Where:

$\eta_{i,BL}$	=	Efficiency of the boiler *i* that would have been used in the baseline instead of the boiler *i* (dimensionless)
$HG_{i,n}$	=	Total amount of steam produced in the baseline boiler *i* in the year *n* of the most recent three years previous to the implementation of the project activity (tonnes of steam)
$HS_{i,n}$	=	Average specific enthalpy of the steam produced in the boiler *i* in year *n* (TJ/tonnes of steam), dependent on the average temperature ($TS_{i,n}$) and pressure ($PS_{i,n}$) of the steam during year *n*
$HW_{i,n}$	=	Average specific enthalpy of the feedwater used in the boiler *i* in year *n* (TJ/tonnes of steam), dependent on the average temperature ($TW_{i,n}$) and pressure ($PW_{i,n}$) of the feedwater during year *n*
$FF_{k,i,n}$	=	Amount of fossil fuel *k* used in the boiler *i* in the year *n* of the most recent three years previous to the implementation of the project activity (mass or volume units)
$NCV_{k,i,n}$	=	Average net calorific value for the fossil fuel *k* used in the boiler *i* in the year *n* of the most recent three years previous to the implementation of the project activity (TJ/mass or volume units)

i	=	Each boiler at each end-user supplied with processed biogas
n	=	Most recent three years previous to the implementation of the project activity.
k	=	Fossil fuel type used in the boiler
y	=	Year of the crediting period

If the heat generation equipment is another heat generation equipment, the efficiency of biogas use ($\eta_{i,BL}$) should be calculated as:

$$\eta_{i,BL} = \sum_{n=1}^{3} \frac{1}{3} \cdot \left[\frac{HG_{i,n}}{\sum_{k} (FF_{k,i,n} \cdot NCV_{k,i,n})} \right] \quad \textbf{(5)}$$

Where:

$\eta_{i,BL}$	=	Efficiency of the heat generation equipment that would have been used in the baseline instead of the heat generation equipment *i* (dimensionless)
$HG_{i,n}$	=	Total amount of heat produced in the heat generation equipment *i* in the year *n* of the most recent three years previous to the implementation of the project activity (tonne of steam)
$FF_{k,i,n}$	=	Amount of fossil fuel *k* used in the heat generation equipment *i* in the year *n* of the most recent three years previous to the implementation of the project activity (mass or volume units)
$NCV_{k,i,n}$	=	Average net calorific value for the fossil fuel *k* used in the heat generation equipment *i* in the year *n* of the most recent three years previous to the implementation of the project activity (TJ/mass or volume units)
i	=	Each heat generation equipment at each end-user supplied with processed biogas
n	=	Most recent three years previous to the implementation of the project activity.
k	=	Fossil fuel type used in the heat generation equipment
y	=	Year of the crediting period

Project emissions

The project emissions should be calculated as follows:

$$PE_y = PE_{elec,y} + PE_{fuel,y} + PE_{biogas,y} + PE_{trans,y} \quad \textbf{(6)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
$PE_{elec,y}$	=	Project emissions due to electricity consumption in year *y* (tCO_2)
$PE_{fuel,y}$	=	Project emissions due to fossil fuels consumption in year *y* (tCO_2)
$PE_{biogas,y}$	=	Project emissions of CH_4 from biogas emitted to the atmosphere before reaching the end-users (leaks, venting, flaring and dissolved in wastewater) in year *y* (tCO_2e)
$PE_{trans,y}$	=	Project emissions from transportation of processed biogas by road vehicles in year *y* (tCO_2
y	=	Year of the crediting period

Calculation of $PE_{elec,y}$

The emissions from electricity consumption due to the project activity include:

- Emissions from electricity consumption as a result of the project activity at the biogas producing site. This includes, for example, electricity consumption from recovering, pre-processing and compression of the biogas at the biogas producing site;
- Emissions from electricity consumption for transportation of the biogas from the biogas producing site to the biogas processing facility;
- Emissions from all electricity consumption at the biogas processing facility;
- Emissions from electricity consumption in the transportation of the processed biogas from the biogas processing facility to the end-users;
- Emissions from any additional electricity consumption at the end-users that may result from the use of processed biogas.

$PE_{elec,y}$ (in tCO_2) should be calculated as per the parameter $PE_{EC,y}$ in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", including all sources of electricity consumption described above (and referred to as electricity consumption sources *j* in the tool).

Calculation of $PE_{fuel,y}$

The emissions from fossil fuel consumption include:

- Emissions from fossil fuel consumption at the biogas producing site (e.g. to recover the biogas);
- Emissions from fossil fuel consumption for transportation of the biogas from the biogas producing site to the biogas processing facility, excluding fossil fuels used for road transportation;
- Emissions from all fossil fuel consumption at the biogas processing facility;
- Emissions from fossil fuel consumption for the transportation of the processed biogas from the biogas processing facility to the end-users, excluding fossil fuels used in vehicles for road transportation;
- Any additional fossil fuel consumption at the end-users that may result from the use of biogas, excluding fossil fuels directly co-fired in the heat generation equipments *i* at the end-users.

$PE_{fuel,y}$ (in tCO_2) should be calculated as per the parameter $PE_{FC,j,y}$ in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where each combustion processes *j* in the tool should correspond to one of the fossil fuel consumption sources described above.

Calculation of $PE_{biogas,y}$

Part of the biogas collected at the biogas producing sites may be emitted to the atmosphere in the form of CH_4 before reaching the end-users. Those CH_4 emissions should be included in the project boundary and accounted for as project emissions. The following sources should be considered:

- Biogas leaks;
- Biogas venting;
- Biogas flaring (CH_4 emissions due to flaring inefficiency);
- Biogas which is dissolved into wastewater during biogas processing.

Individual emission sources have to be calculated as per the following equation:

$$PE_{biogas,y} = PE_{leaks,y} + PE_{vent,y} + PE_{flare,y} + PE_{ww,y} \quad \textbf{(7)}$$

Where:

$PE_{biogas,y}$	=	Project emissions of CH_4 from biogas emitted to the atmosphere before reaching the end-users (leaks, venting, flaring and dissolved in wastewater) in year *y* (tCO_2e)
$PE_{leaks,y}$	=	Project emissions due to biogas leaks within the project boundary in year *y* (tCO_2e)
$PE_{vent,y}$	=	Project emissions due to biogas venting within the project boundary in year *y* (tCO_2e)
$PE_{flare,y}$	=	Project emissions due to biogas flaring within the project boundary in year *y* (tCO_2e)
$PE_{ww,y}$	=	Project emissions due to biogas emissions from wastewater in year *y* (tCO_2e)

Calculation of $PE_{leaks,y}$

If the most plausible baseline scenario for the biogas producing site is venting of biogas or flaring of biogas in open flares, disregard this emission source and assign the value of $PE_{leaks,y}$ as zero.

In case, the most plausible baseline scenario for the biogas producing site is flaring of biogas in closed flares, $PE_{leaks,y}$ should be accounted for as following:

$$PE_{leaks,y} = PE_{leaks,plants,y} + PE_{leaks,pipeline,y} + PE_{leaks,vehicles,y} \quad (8)$$

Where:

$PE_{leaks,y}$	=	Project emissions due to biogas leaks within the project boundary in year *y* (tCO_2)
$PE_{leaks,plants,y}$	=	CH_4 emissions from the project activity at the gas recovery facility and the gas processing plant during the year *y* (tCO_2)
$PE_{leaks,pipeline,y}$	=	CH_4 leak emissions from the project activity during the transport of the gas in pipelines during the year *y* (tCO_2)
$PE_{leaks,vehicles,y}$	=	CH_4 leak emissions from transport of the gas by road vehicles during the year *y* (tCO_2)

Calculation of CH_4 emissions from the project activity at the gas recovery facility and the gas processing plant ($PE_{leaks,plants,y}$)

Fugitive CH_4 emissions occurring during the recovery and processing of gas may in some projects be small, but should be estimated as a conservative approach. Emission factors may be taken from the IPCC Good Practice Guidance and/or from the 1995 Protocol for Equipment Leak Emission Estimates, published by EPA[9]. Emissions should be determined for all relevant activities and all equipment (such as valves, pump seals, connectors, flanges, open-ended lines, etc.).

[9] Please refer to Document EPA-453/R-95-017 at <http://www.epa.gov/ttn/chief/efdocs/lks95_ch.pdf>

Where the average emission factor approach by EPA is used to estimate emissions from the production of recovered gas and from the gas processing plant, emissions should be estimated separately for streams with different compositions. The following data needs to be obtained to follow this approach:

- The number of each type of component in a unit (valve, connector, etc.);
- The total organic compound and methane concentration of the stream; and,
- The time period each component is in that service.

The EPA approach is based on average emission factors for total organic compounds (TOC). Methane emissions are calculated for single equipment by multiplying the CH_4 concentration in the respective stream with the appropriate emission factor from Table 2.

$$PE_{leaks,plants,y} = GWP_{CH4} \cdot \frac{1}{1000} \cdot \sum_{equipment} w_{CH4,TOC,y} \cdot EF_{equipment} \cdot T_{equipment} \quad \textbf{(9)}$$

Where:

$PE_{leaks,plants,y}$	=	CH_4 emissions from the project activity at the gas recovery facility and the gas processing plant during the year *y* (tCO_2)
GWP_{CH4}	=	Global Warming Potential for methane
$T_{equipment}$	=	Operation time of the equipment in hours (in absence of further information, the monitoring period could be considered as a conservative approach)
$w_{CH4,TOC,y}$	=	Average methane weight fraction with respect to TOC content in the respective biogas stream in the year *y* ($kgCH_4$/kg of TOC)
$EF_{equipment}$	=	Appropriate emission factor from Table 2 in kg of TOC/hour

For the purpose of this calculation it is recommended to group the equipment according to the different stream types.

Table 2: Gas production operations average emission factors

Equipment Type	Emission Factor (kg of TOC/hour)[b]
Valves	4.5E-03
Pump seals	2.4E-03
Others[a]	8.8E-03
Connectors	2.0E-04
Flangs	3.9E-04
Open-ended lines	2.0E-03

Source: US EPA-453/R-95-017 Table 2.4, page 2-15

(a) “Other” equipment type was derived from compressors, diaphragms, drains, dump arms, hatches, instruments, meters, pressure relief valves, polished rods, relief valves and vents. This “other” equipment type should be applied for any equipment type other than connectors, flanges, open-ended lines, pumps or valves.

(b) These factors are for total organic compound emission rates (including non-VOC’s such as methane and ethane).

Where the IPCC GPG 2000 is used to estimate fugitive CH_4 emissions, the appropriate refined Tier 1 emission factors in Table 2.16 of the IPCC GPG should be applied.

Calculation of CH_4 leak emissions from the project activity during the transport of the gas in pipelines

Fugitive CH_4 leak emissions occurring during the transport of the gas in pipelines maybe small in some projects, but should be estimated as the same approach as "*Calculation of CH_4 leak emissions from recovery and processing the gas*" explained above.

$$PE_{leaks,pipeline,y} = GWP_{CH4} \cdot \frac{1}{1000} \cdot \sum_{equipment} w_{CH4,TOC,y} \cdot EF_{equipment} \cdot T_{equipment} \quad \textbf{(10)}$$

Where:

$PE_{leaks,pipeline,y}$	=	CH_4 leak emissions from the project activity during the transport of the gas in pipelines under the normal operation during the period y in tons of CO_2 equivalents
GWP_{CH4}	=	Global Warming Potential for methane
$T_{equipment}$	=	Operation time of the equipment in hours (in absence of further information, the monitoring period could be considered as a conservative approach)
$w_{CH4,TOC,y}$	=	Average methane weight fraction with respect to TOC content in the respective biogas stream in the year *y* ($kgCH_4$/kg of TOC)
$EF_{equipment}$	=	Appropriate emission factor from Table 2 in kg of TOC/hour

Calculation of CH_4 leak emissions from transport of the gas by road vehicles

CH_4 leak emissions from the project activity during the transport of the gas by road vehicles (e.g. trucks) in year *y* should be calculated as:

$$PE_{leaks,vehicles,y} = GWP_{CH4} \cdot \frac{1}{1000} \cdot LR_{biogas} \cdot w_{CH4,bogas,y} \cdot BG_{trans,y} \quad \textbf{(11)}$$

Where:

$PE_{leaks,vehicles,y}$	=	CH_4 emissions from the project activity during the transport of the gas in by vehicles (e.g. trucks) under the normal operation during the period y in tons of CO_2 equivalents
GWP_{CH4}	=	Global Warming Potential for methane
LR_{biogas}	=	Rate of biogas that leaks during transportation by road vehicles (dimensionless).
$w_{CH4,biogas,y}$	=	Average methane weight fraction in the respective biogas stream in the year *y* (tCH_4/tonnes of biogas)
$BG_{trans,y}$	=	Total amount of biogas loaded in road vehicles at the biogas processing facility (tonnes)

Calculation of $PE_{flare,y}$

For biogas streams which are flared, emissions due to the incomplete or inefficient combustion of the biogas should be calculated using the "Tool to determine project emissions from flaring gases containing methane", as the parameter $PE_{flare,y}$.

Calculation of $PE_{vent,y}$

For biogas streams which are vented, monitoring procedures and emissions calculations should be guided by the same "Tool to determine project emissions from flaring gases containing methane", however, without considering measurements and calculations for the flare efficiency. Therefore, emissions are calculated as the parameter $PE_{flare,y}$, assuming that the flare efficiency $\eta_{flare,h}$ is zero.

Calculation of $PE_{ww,y}$

This is applicable to cases where the biogas processing facility generates wastewater which is a source of fugitive emissions of CH_4. It is assumed that all the methane contained in the wastewater is emitted to the atmosphere. The related project emissions are, therefore, calculated as follows:

$$PE_{ww,y} = Q_{ww,y} \cdot w_{ww,y} \quad \textbf{(12)}$$

Where:

$PE_{ww,y}$	=	Project emissions due to biogas emissions from wastewater in year y (tCO_2)
$Q_{ww,y}$	=	Volume of wastewater produced in year y (m^3/year)
$w_{ww,y}$	=	Average concentration of methane dissolved in the wastewater in year y (tCH_4/m^3)

Calculation of $PE_{trans,y}$

In cases where the processed biogas is transported by road, transport related emissions should be accounted for by choosing one of the following options:

Option 1: Emissions are calculated on the basis of distance and the number of trips (or the average truck load):

$$PE_{trans,y} = N_y \cdot AVD_y \cdot EF_{km,CO2,y}$$

or

$$PE_{trans,y} = \frac{BG_{trans,y}}{TL_y} \cdot AVD_y \cdot EF_{km,CO2,y} \quad \textbf{(13)}$$

Where:

$PE_{trans,y}$	=	Project emissions from transportation of processed biogas by road (tCO_2).
N_y	=	Number of truck trips during the year y
AVD_y	=	Average round trip distance (from and to) between origin and destination during the year y (km)
$EF_{km,CO2,y}$	=	Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km)
$BG_{trans,y}$	=	Total amount of biogas loaded in road vehicles at the biogas processing facility during the year y (tonnes)
TL_y	=	Average truck load of the trucks used during the year y (tonnes)
y	=	Year of the crediting period

Option 2: Emissions are calculated based on the actual quantity of fossil fuels consumed for transportation:

$$PE_{trans,y} = \sum_k \left(FC_{TR,k,y} \cdot NCV_{TR,k} \cdot EF_{CO2,FF,k} \right) \quad \textbf{(14)}$$

Where:

$PE_{trans,y}$	=	Project emissions from transportation of processed biogas by road during year y (tCO_2)
$FC_{TR,k,y}$	=	Fuel consumption of fuel type k in trucks for transportation of biogas during the year y (mass or volume units)
$NCV_{TR,k}$	=	Net calorific value of fossil fuel type k consumed for transportation (GJ/mass or volume units)
$EF_{CO2,FF,k}$	=	CO_2 emission factor for fossil fuel type k consumed for transportation (tCO_2/GJ)
k	=	Fossil fuel types used for transportation of biogas in year y.
y	=	Year of the crediting period

Leakage

No leakage emissions are considered.

Emission Reductions

The emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \tag{15}$$

Where:

ER_y	=	Emissions reductions during year y (tCO_2e)
BE_y	=	Baseline emissions during year y (tCO_2e)
PE_y	=	Project emissions during year y (tCO_2e)

Changes required for methodology implementation in 2nd and 3rd crediting periods

To request renewal of a crediting period, project participants should demonstrate that changes in local/national laws and regulations and/or their enforcement occurred during the past crediting period do not affect the continued validity of the baseline. Project participants should also update emission factors for the fossil fuels combusted or for electricity used in the project activity.

Data and parameters not monitored

Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential for CH_4
Source of data:	IPCC
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	-

Parameter:	$HG_{i,n}$
Data unit:	Tonnes of steam or TJ
Description:	Total amount of steam or heat produced in the baseline boiler or heat generation equipment *i*, as applicable, in the year *n* of the most recent three years previous to the implementation of the project activity.
Source of data:	Historical average measurements
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$HS_{i,n}$
Data unit:	TJ/tonnes of steam
Description:	Average specific enthalpy of the steam produced in the boiler *i* in year *n*, dependent on the average temperature ($TS_{i,n}$) and pressure ($PS_{i,n}$) of the steam during year *n*.
Source of data:	Historical average measurements
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$HW_{i,n}$
Data unit:	TJ/tonnes of steam
Description:	Average specific enthalpy of the feedwater used in the boiler *i* in year *n*, dependent on the average temperature ($TW_{i,n}$) and pressure ($PW_{i,n}$) of the feedwater during year *n*.
Source of data:	Historical average measurements
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$FF_{k,i,n}$
Data unit:	mass or volume units
Description:	Amount of fossil fuel *k* used in the boiler or heat generation equipment *i*, as applicable, in the year *n* of the most recent three years previous to the implementation of the project activity.
Source of data:	Historical average measurements
Measurement procedures (if any):	Use mass or volume meters
Any comment:	-

<table>
<tr><td>Parameter:</td><td>$NCV_{k,i,n}$</td></tr>
<tr><td>Data unit:</td><td>TJ/mass or volume units</td></tr>
<tr><td>Description:</td><td>Average net calorific value for the fossil fuel k used in the boiler i in the year n of the most recent three years previous to the implementation of the project activity.</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A).</td></tr>
<tr><td>b) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>c) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>-</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

<table>
<tr><td>Parameter:</td><td>$EF_{i,BL}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2/TJ</td></tr>
<tr><td>Description:</td><td>Emission factor of the fossil fuel that would have been used instead of the biogas in heat generation equipment i in the baseline.</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>-</td></tr>
<tr><td>Any comment:</td><td>If more than one fuel is used, e.g. in multi fuel equipments or co-firing schemes, the lowest emission factor of the fuels used should be taken, as a conservative approach.</td></tr>
</table>

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Gas-tightening condition

In order to assure that the gas-tightening condition is maintained during the operation of the upgrading plant, project participants should introduce the following practices aiming to systematically identify leaks and undertake necessary repairs:

- Project participants may use advanced tools to detect leaks in the upgrading facility, such as Electronic Screening with hand-held gas detectors or "sniffers", Organic Vapor Analyzers (OVAs) and Toxic Vapor Analyzers (TVA), or Acoustic Leak Detection using acoustic screening devices;
- Project participants should test the gas-tightening condition at least once a month, and should maintain a detailed record of every survey including the name of a person who performed the test, the device used for the survey, detailed description of the test performed and follow-up actions to be taken;
- The test should cover the entire upgrading facility and should be performed by trained personnel using certified devices;
- Project participants should tag and number every leak identified and the related equipment should be repaired immediately; if necessary pieces of equipment should be replaced;
- Detailed schedule of the replacement of equipment provided by the manufacturer must be available; equipment should be replaced at least when required by the manufacturer.

If during the gas-tightening test major leaks are found, project participants should stop the upgrading process until the equipment is repaired.

Flaring of biogas by an "emergency flare" at the site of biogas capture

During the periods when the upgrading facility is closed due to the scheduled maintenance, reparation of equipment as described above, or other emergency, project participants should ensure that the captured biogas is flared. Appropriate monitoring procedures should be established to monitor this "emergency flare".

Data and parameters monitored

Data / Parameter:	$BG_{i,y}$
Data unit:	mass or volume units
Description:	Amount of processed biogas supplied to the boiler or heat generation equipment *i,* as applicable, in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use mass or volume meters
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{BG,y}$</td></tr>
<tr><td>Data unit:</td><td>TJ/mass or volume units</td></tr>
<tr><td>Description:</td><td>Average net calorific value of the processed biogas in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A).</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards.</td></tr>
<tr><td>Monitoring frequency:</td><td>Monthly</td></tr>
<tr><td>QA/QC procedures:</td><td>Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	$HG_{i,y}$
Data unit:	Tonnes or TJ
Description:	Amount of steam or heat produced in the boiler or heat generation equipment *i*, as applicable, in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$HS_{i,y}$
Data unit:	TJ/tonnes of steam
Description:	Average specific enthalpy of the steam produced in the boiler *i* in year *y*.
Source of data:	On-site measurements
Measurement procedures (if any):	Steam meter for flow measurement. Pressure gauge and Temperature indicator for pressure and temperature measurements respectively. Steam table for enthalpy determination at given average temperature ($TS_{i,y}$) and pressure ($PS_{i,y}$) of the steam during year *y*
Monitoring frequency:	Monthly
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$HW_{i,y}$
Data unit:	TJ/tonnes of steam
Description:	Average specific enthalpy of the feedwater used in the boiler *i* in year *y*.
Source of data:	On-site measurements
Measurement procedures (if any):	Steam meter for flow measurement. Pressure gauge and Temperature indicator for pressure and temperature measurements respectively. Steam table for enthalpy determination at given average temperature ($TW_{i,y}$) and pressure ($PW_{i,y}$) of the feedwater during year *y*
Monitoring frequency:	Monthly
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$FF_{k,i,y}$
Data unit:	mass or volume units
Description:	Amount of fossil fuel *k* used in the boiler or heat generation equipment *i*, as applicable, in year *y*, if any
Source of data:	On-site measurements
Measurement procedures (if any):	Use mass or volume meters
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$NCV_{k,i,y}$
Data unit:	TJ/mass or volume units
Description:	Average net calorific value for the fossil fuel *k* used in the boiler or heat generation equipment *i,* as applicable, in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply: <table><tr><td>Data source</td><td>Conditions for using the data source</td></tr><tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A).</td></tr><tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr><tr><td>c) Regional or national default values</td><td>If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr><tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr></table>
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	Monthly
QA/QC procedures:	Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	

Data / Parameter:	$T_{equipment}$
Data unit:	hours
Description:	Operation time of the equipment.
Source of data:	On-site measurements
Measurement procedures (if any):	Choose one of the option below: 1) Conservative value of 8760 hours 2) Monitored time of operation
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$w_{CH4,TOC,y}$
Data unit:	kgCH_4/kg of TOC
Description:	Average methane weight fraction with respect to TOC content in the respective biogas stream in the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Choose one of the option below: 1) Conservative value of 1 2) Monitored value
Monitoring frequency:	Monthly
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	

Data / Parameter:	$w_{CH4,biogas,y}$
Data unit:	kgCH_4/kg of biogas
Description:	Average methane weight fraction in the respective biogas stream in the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Choose one of the option below: 1) Conservative value of 1 2) Monitored value
Monitoring frequency:	Monthly
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	

Data / Parameter:	LR_{biogas}
Data unit:	dimensionless
Description:	Rate of biogas that leaks during transportation by road vehicles
Source of data:	-
Measurement procedures (if any):	Choose one of the option below: 1) Conservative figure based of scientific literatures 2) Monitored leak rate
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	In case project participants wish to monitor rate of biogas leak during transportation by road vehicles, they should request for review of this methodology with monitoring methods

Data / Parameter:	$Q_{ww,y}$
Data unit:	m^3/year
Description:	Volume of wastewater produced in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$w_{ww,y}$
Data unit:	tCH_4/m^3
Description:	Average concentration of methane dissolved in the wastewater in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Monthly
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	N_y
Data unit:	Dimensionless
Description:	Number of truck trips during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	AVD_y
Data unit:	km
Description:	Average round trip distance (from and to) between origin and destination during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$EF_{km,CO2,y}$
Data unit:	tCO_2/km
Description:	Average CO_2 emission factor for the trucks measured during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$BG_{trans,y}$
Data unit:	tonnes
Description:	Total amount of biogas loaded in road vehicles at the biogas processing facility during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	TL_y
Data unit:	tonnes
Description:	Average truck load of the trucks used during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	As recommended by the manufacturer or local/national standards
Any comment:	-

Data / Parameter:	$FC_{TR,k,y}$
Data unit:	mass or volume units
Description:	Fuel consumption of fuel type *k* in trucks for transportation of biogas during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use mass or volume meters
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{TR,k}$</td></tr>
<tr><td>Data unit:</td><td>GJ/mass or volume units</td></tr>
<tr><td>Description:</td><td>Net calorific value of fossil fuel type k consumed for transportation.</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A).</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>Monthly</td></tr>
<tr><td>QA/QC procedures:</td><td>Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	$EF_{CO2,FF,k}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for fossil fuel type *k* consumed for transportation
Source of data:	The following data sources may be used if the relevant conditions apply:
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices	This is the preferred source
b) Measurements by the project participants	If a) is not available
c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available

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History of the document

Version	**Date**	**Nature of revision(s)**
01	EB 45, Annex # 13 February 2009	Initial adoption.