Revision to the approved baseline methodology AM0019

"Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects"

Source

This methodology is based on the Lihir Geothermal Power Project, Papua New Guinea whose baseline study, monitoring and verification plan and project design document were prepared by SMEC-HGM Pty Limited and Ecosecurities Limited. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0053: "Lihir Geothermal Power Project CDM Project Design Document" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions as applicable."

Applicability

This methodology is applicable to:

- proposed project activities where electricity production from the zero-emission renewable energy sources: wind, geothermal, solar, run-of-river hydro, wave and/or tidal projects that displaces electricity production from an identified, individual, plant;
- New hydro electric power projects with reservoirs having power densities (installed power generation capacity divided by the surface area at full reservoir level) greater than 4 W/m^2.[1]
- where the identified baseline plant has sufficient capacity to meet the increase of demand expected during the crediting period.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0019 ("Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects").

Project activity

The project activity involves the construction of a renewable energy power plant (excluding biomass).

Overall description:

When applicable, the methodology can be applied through the following five steps:

- Step 1 - Demonstrate that the proposed project activity only displaces the electricity of one identified, individual power plant,
- Step 2 – Demonstrate that the proposed project activity is not the business as usual scenario,
- Step 3 – Determine the Carbon Emission Factor of the existing power plant,

[1] The adoption of this guidance does not prevent project participants from submiting new methodologies for hydroelectric projects, for consideration by the Meth Panel, in particular where reservoirs have no significant vegetative biomass in the catchments area.

- Step 4 - Calculate project emissions,
- Step 5 – Calculate baseline emissions and emission reductions of the proposed project activity.

Step 1 – Demonstrate that the proposed project activity only displaces the electricity of one identified, individual power plant

The proposed project activity should provide a brief background description of the project sector and context. This description should demonstrate that the project only displaces the electricity of one single power plant. This plant should be specifically identified. Documented explanations should be provided as to why it is unlikely that other plants, other than the proposed project activity, would be built during the crediting period. The DOE should assess the validity of this explanation.

The project proponent should also demonstrate that the remaining technical and economic lifetime of the existing plant is at least equal to or exceeds the crediting period of the proposed CDM project. In case any refurbishments in the identified baseline plant would have deemed to be likely during this period, the baseline plant is still eligible for this methodology, provided that any efficiency improvements from the refurbishments are estimated in a conservative, transparent manner and included in the baseline calculations in Step 3.

In case the project is connected to a grid with more than one power plant, it should be made explicitly clear why the electricity is displaced from only one power plant and not from a mix of plants providing electricity to the grid. These claims should be backed up by verifiable documentation.

Step 2 – Demonstrate and assess additionality

To demonstrate that the proposed project activity is additional project participants shall use the latest version of the **"Tool for the demonstration and assessment of additionality"** agreed by the CDM Executive Board[2].

Step 3 - Determine the Carbon Emission Factor of the Existing Power Plant

Assuming that the proposed project activity meets the applicability criteria for this project, the existing performance and fuel consumption of the plant that will be displaced by the project activity can be used to calculate the Carbon Emission Factor (CEF).
To determine the CEF of this plant, collect data on fuel consumption of the plant. The data available for the average of the three most recent years for which the performance data of the plant are complete and accurate should be used.

CEF calculation formula:

The CEF for the individual power plant can be calculated using the following formula:

$$EF_{bl} = COEF_{bl,y} * F_{bl} / GEN_{bl} \quad \textbf{(1)}$$

where

EF_{bl} = Emission Factor for the electricity produced by the identified plant that will be displaced by the project activity (as identified under Step 1);

F_{bl},y = is the fuel consumption (in a mass or volume unit) of the identified baseline plant during the year y;

$COEF_{bl,y}$ = is the CO_2 emission factor coefficient (expressed as tCO_2 per mass or volume unit) of the fuel consumed by the identified baseline plant;
$GEN_{bl,y}$ = is the number of MWh produced by the identified baseline plant in year y.

[2] Please refer to : < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.

The EF_{BL} is a fixed EF per MWh and remains constant for every year in the crediting period. The EF should be calculated using a 3-year average, based on the most recent statistics available at the time of CDM-PDD submission. If the proposed project activity would opt for a renewable crediting period, the EF_{bl} needs to be recalculated at the end of each crediting period to ascertain a conservative EF_{bl} through the entire crediting period.

Step 4 – Calculate project emissions (if applicable)
For most renewable energy project activities, project emissions are zero. However, for following categories of projects, project emissions needs to be estimated:
(I) Geothermal project activities project participants shall account the following emission sources[3], where applicable:

- Fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam; and
- Carbon dioxide emissions resulting from combustion of fossil fuels related to the operation of the geothermal power plant.

The data to be collected are listed in the associated monitoring methodology AM0019 ("Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects"). Project emissions should be calculated as follows:

a) Fugitive carbon dioxide and methane emissions due to release of non-condensable gases from the produced steam (PES_y):

$$PES_y = (w_{Main,CO2} + w_{Main,CH4} * GWP_{CH4})*M_{S,y} \qquad \textbf{(2)}$$

where

PES_y = the project emissions due to release of carbon dioxide and methane from the produced steam during the year y,
$w_{Main,CO2}$ and $w_{Main,CH4}$ = the average mass fractions of carbon dioxide and methane in the produced steam
GWP_{CH4} = the global warming potential of methane;
$M_{S,y}$ is the quantity of steam produced during the year y.

b) Carbon dioxide emissions from fossil fuel combustion ($PEFF_y$)

$$PEFF_y = \sum F_{i,y} * COEF_i \qquad \textbf{(3)}$$

where

$PEFF_y$ = the project emissions from combustion of fossil fuels related to the operation of the geothermal power plant in tons of CO2;
$F_{i,y}$ = is the fuel consumption of fuel type i during the year y;
$COEF_i$ = the CO2 emission factor coefficient of the fuel type i.

[3] Fugitive carbon dioxide and methane emissions due to well testing and well bleeding are not considered as they are negligible.

Thus, for geothermal project activities,

$$PE_y = PES_y + PEFF_y \quad \textbf{(4)}$$

II) New Hydro electric power projects with reservoirs, project proponents shall account for project emissions, estimated as follows:

a) if the power density of project is greater than $4W/m^2$ and less than or equal to $10W/m^2$:

$$PE_y = \frac{EF_{Res} * EG_y}{1000}$$

where,

PE_y	Emission from reservoir expressed as tCO_2e/year
ES_{Res}	is the default emission factor for emissions from reservoirs, and the default value as per EB23 is 90 Kg CO_2e /MWh.
EG_y	Electricity produced by the hydro electric power project in year y, in MWh

b) If power density of the project is greater than $10W/m^2$

$PE_y = 0$.

Step 5 - Calculate baseline emissions and emission reductions for the crediting period

The emission reduction *ERy* by the project activity during a given year *y* is the difference between baseline emissions (*BEy*), project emissions (*PEy*) and emissions due to leakage (*Ly*), as follows:

$$ER_y = BE_y – PE_y – L_y \quad \textbf{(5)}$$

where the baseline emissions (*BEy* in tCO_2) are the product of the baseline emissions factor (EF_{BL} in tCO_2/MWh) calculated in Step 3, times the electricity supplied by the project activity to the grid (EG_y in MWh), as follows:

$$BE_y = EG_y * EF_{BL} \quad \textbf{(6)}$$

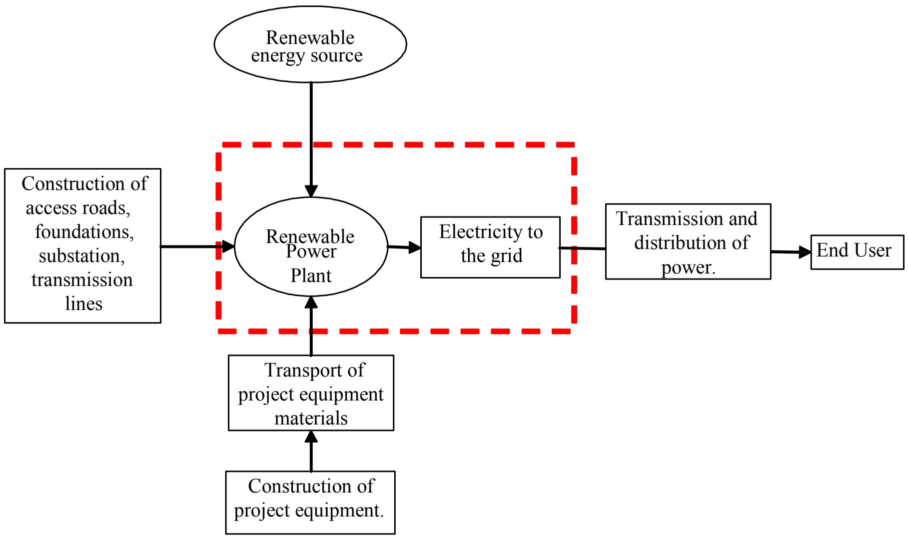
This methodology, and the equation above, only holds if the deployed capacity at a given hour of the baseline plant ($MWh_{h, BL}$) and the project plant ($MWh_{h, P}$) are lower than the maximum capacity of the baseline plant ($MWh_{max, BL}$) at all times during the crediting period.
$MWh_{max, BL}$ should be provided in the CDM-PDD and ($MWh_{h, BL}$+ $MWh_{h, P}$).

The parameters ($MW_{h, BL}$+ $MW_{h, P}$) are to be monitored and are included in the associated monitoring methodology AM0019 (“Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects”).

Project boundary

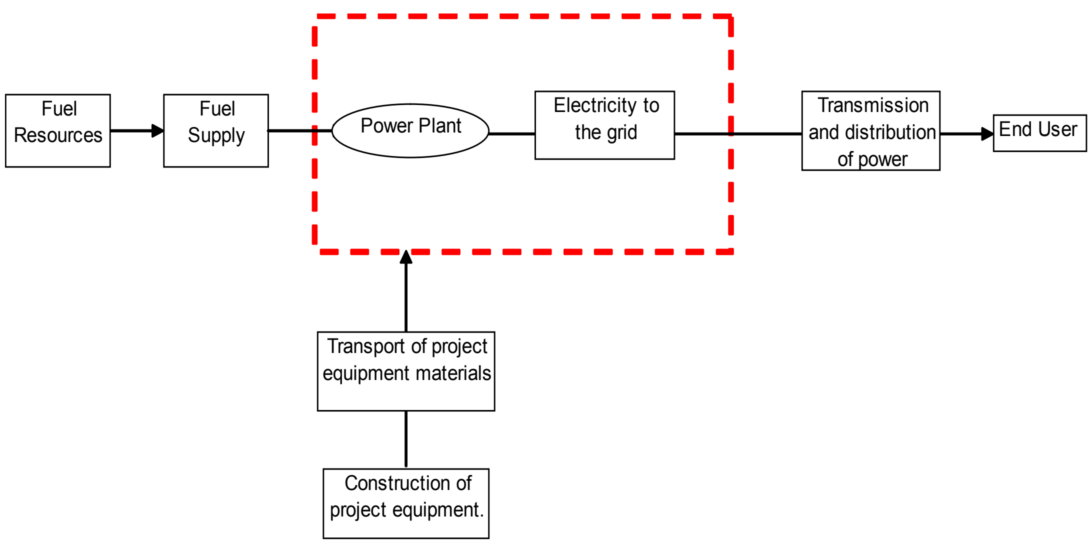
A full flow diagram of the proposed project activity and system boundaries is presented in Figure A3.1 below. The flow diagram comprises all possible elements for the development of a renewable energy project.

Figure 1: Project Delivery System



The flowchart in figure 1 below presents the current delivery system for a single project that will displaced by the proposed project activity, including the boundaries defined for the activities in the scenario without the renewable energy project (baseline scenario). The red dotted line presents the project boundary. It should be noted that in case the power plant in the baseline situation stand-alone, the right-hand side of figure 2 needs to be adjusted. Instead of electricity to the grid and transmission and distribution there will only be the end-user.

Figure 2: Current Delivery System



The following principles have been taken into account when defining the project boundaries:

1. Project participants shall account only the following emission sources for the project activity:

- For geothermal project activities, fugitive emissions of methane and carbon dioxide from non-condensable gases contained in geothermal steam and carbon dioxide emissions from combustion of fossil fuels required to operate the geothermal power plant;
- For new hydroelectric projects with reservoirs, the project boundary includes the physical site of the plant as well as the reservoir area.
- For the baseline determination, project participants shall only account CO_2 emissions from electricity generation in fossil fuel fired power that is displaced due to the project activity.

2. Emissions related to activities one step downstream and one step upstream should be included.

Assessment of uncertainties

The proposed methodology can lead to an erroneous baseline scenario if data on historic performance of the specific plant is included for one year only. This risk has been reduced by requiring the data used for the performance of the plant to be based on three years average rather than a one-year average.

Additionality

In Step 2 the baseline methodology refers to the use of the latest version of **"Tool for the demonstration and assessment of additionality"** approved by the CDM Executive Board[4].
In Step 3 above, the baseline methodology addresses the calculation of baseline emissions by an emission factor calculation formula.
To determine the total amount of baseline emissions within the crediting period the emissions calculated for each year within the crediting period should be accumulated. This is done in Step 5.

Leakage

No significant sources of leakage are to be expected for renewable energy projects.[5] The energy prices will not be reduced due to the addition of a renewable energy project and thus there is no risk that it will result in a higher consumption of electricity by the end-users. A possible source of leakage might be that the emissions during the construction phase of the proposed project activity turn out to be significant. However, this is very unlikely to be higher than 1% and therefore considered to be insignificant and thus not a source of leakage.

Crediting period

The crediting period of the project activity shall not exceed the remaining technical and economic lifetime of the existing plant.

[4] Please refer to : < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.
[5] Biomass energy was specifically excluded from this methodology because both the project boundaries and leakage issues are more complex for that energy source.

Revision to the approved monitoring methodology AM0019

"Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects"

Source

This methodology is based on the Lihir Geothermal Power Project, Papua New Guinea whose baseline study, monitoring and verification plan and project design document were prepared by SMEC-HGM Pty Limited and Ecosecurities Limited. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0053: "Lihir Geothermal Power Project CDM Project Design Document" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

Applicability

This methodology is applicable to projects generating power by renewable energy sources under the following conditions:

- proposed project activities where electricity production from the zero-emission renewable energy sources: wind, geothermal, solar, run-of-river hydro, wave and/or tidal projects that displaces electricity production from an identified, individual, plant;
- New hydro electric power projects with reservoirs having power densities (installed power generation capacity divided by the surface area at full reservoir level) greater than 4 W/m^2.[6]
- where the identified baseline plant has sufficient capacity to meet the increase of demand expected during the crediting period.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0019 ("Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects").

Monitoring Methodology

The methodology requires monitoring of the following:
- Electricity generation from the proposed project activity;
- For geothermal power projects, data needed to calculate fugitive carbon dioxide and methane emissions and carbon dioxide emissions from combustion of fossil fuels required to operate the geothermal power plant.
- For new hydro electric power projects, the surface area of reservoir at the full reservoir level.

The project needs to monitor its electricity production following standard practices of electricity metering. The net electricity generated by the project need to be monitored through the use of on site metering equipment at the substation (interconnection facility connecting the facility to the grid). The meter reading records will have to be readily accessible for auditors and calibration tests records will be maintained for the auditors.

[6] The adoption of this guidance does not prevent project participants from submiting new methodologies for hydroelectric projects, for consideration by the Meth Panel, in particular where reservoirs have no significant vegetative biomass in the catchments area.

In case the project is selling its electricity under a Power Purchase Agreement (PPA) the PPA and its relating payments can be used to verify the amount of electricity has been generated. In case this is not done, the project needs to specify how the generated electricity figures can be verified.
The deployed capacity at a given hour of the baseline plant ($MWh_{h, BL}$) and the project plant ($MWh_{h, P}$) should be lower than the maximum capacity of the baseline plant for a given hour ($MWh_{max, BL}$). If this is higher, this methodology can not be applied.
$MWh_{max, BL}$ should be provided in the CDM-PDD and ($MWh_{h, BL}$+ $MWh_{h, P}$) can be derived from the continuous monitoring of the electricity production of the project, $EG_{y, power plant}$, and the electricity production of the baseline plant $EGy,_{baseline plant.}$. A special record should be kept in which these two parameters are added.

Project boundary
The project boundary of this monitoring methodology is similar to the project boundary of the baseline methodology AM0019 ("Renewable energy projects replacing the electricity of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects.")

It includes the following emissions sources:

- For geothermal project activities, fugitive emissions of methane and carbon dioxide from non-condensable gases contained in geothermal steam and carbon dioxide emissions from combustion of fossil fuels required to operate the geothermal power plant;
- For new hydroelectric projects with reservoirs, the project boundary includes the physical site of the plant as well as the reservoir area.
- For the baseline determination, project participants shall only account CO2 emissions from electricity generation in fossil fuel fired power that is displaced due to the project activity;

Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	For how long is archived data to be kept?	Comment
	Area	Surface area of reservoir at full reservoir level	m^2	m	At start of project	100%	Electronic	Until two years after the last issuance of CERs for this project	
1. $EG_{y, power plant}$	Net electrical output	Electricity supplied to the grid by the project	MWh	m	continuous	100%	electronic	Until two years after the last issuance of CERs for this project	Results can be cross checked with sales receipts of power consumption data
2. $EGy,_{baseline plant}$	Net electrical output	Electricity supplied to the grid by the existing plant	MWh	m	continuous	100%	electronic	Until two years after the last issuance of CERs for this project	If baseline plant will be abolished, this monitoring value can be put at 0 after approval by DOE responsible for verification.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	For how long is archived data to be kept?	Comment
3. $MW_{h, BL}$ + $MW_{h, P}$	Capacity deployed at specific hour h	Capacity rating	MW	c	continuous	100%	electronic	Until two years after the last issuance of CERs for this project	If baseline plant will be abolished, this monitoring value can be put at 0 after approval by DOE responsible for verification.
4. MS, y	Mass quantity	Quantity of steam produced during year y.	t	m	daily	100%	electronic	Until two years after the last issuance of CERs for this project	See note 1
5. $w_{Main,CO2}$	Mass fraction	Fraction of CO_2 in produced steam	tCO_2 / t steam	M	every 4 months	100%	electronic	Until two years after the last issuance of CERs for this project	See note 2
6. $w_{Main,CH4}$	Mass fraction	Fraction of CH_4 in produced steam	tCH_4 / t steam	M	every 4 months	100%	electronic	Until two years after the last issuance of CERs for this project	See note 2

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	For how long is archived data to be kept?	Comment
7. MS, y	Mass quantity	Quantity of steam produced during year y.	t	M	daily	100%	electronic	Until two years after the last issuance of CERs for this project	See note 1
8. $w_{Main,CO2}$	Mass fraction	Fraction of CO_2 in produced steam	tCO_2 / t steam	M	every 4 months	100%	electronic	Until two years after the last issuance of CERs for this project	See note 2
9. $w_{Main,CH4}$	Mass fraction	Fraction of CH_4 in produced steam	tCH_4 / t steam	M	every 4 months	100%	electronic	Until two years after the last issuance of CERs for this project	See note 2

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	For how long is archived data to be kept?	Comment
10. $F_{i,y}$	Fuel quantities	Amount of fossil fuels used for the operation of the geothermal plant	Mass or volume	M	monthly	100%	electronic	Until two years after the last issuance of CERs for this project	
11. $COEF_i$	Emission factor coefficient	CO_2 emission coefficients of fossil fuel types I used for the operation of the geothermal plant	tCO_2 / mass or volume unit	M	As required	100%	electronic	Until two years after the last issuance of CERs for this project	Plant or country specific values are preferred to IPCC default values
12. EF_{bl}	Emission factor	CO_2 emission factor of baseline power plant	tCO_2/MWh	c	At the beginning of each crediting period	100%	electronic	Until two years after the last issuance of CERs for this project	Only applicable if renewable crediting period is chosen. See baseline methodology for further instructions
13. $COEF_{bl,y}$	Emission factor coefficient	CO_2 emission coefficients of fossil fuel type used for the operation of the baseline plant in final 3 years before renewal of crediting period	tCO_2 / mass or volume unit	m	At the beginning of each crediting period	100%	electronic	Until two years after the last issuance of CERs for this project	Only applicable if renewable crediting period is chosen. See baseline methodology for further instructions

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	For how long is archived data to be kept?	Comment
14. F_{bl}	Fuel quantities	Amount of fossil fuels used for the operation of the baseline plant in final 3 years before renewal of crediting period	Mass or volume	m	At the beginning of each crediting period	100%	Electronic	Until two years after the last issuance of CERs for this project	Only applicable if renewable crediting period is chosen. See baseline methodology for further instructions
15. GEN_{bl}	Electricity quantity	Electricity generation of the baseline power plant in final 3 years before renewal of crediting period	MWh/y		At the beginning of each crediting period	100%	Electronic	Until two years after the last issuance of CERs for this project	Only applicable if renewable crediting period is chosen. See baseline methodology for further instructions

Note 1: Steam flow rate, power plant

The steam quantity discharged from the geothermal wells should be measured with a venture flow meter (or other equipment with at least the same accuracy). Measurement of temperature and pressure upstream of the venture meter is required to define the steam properties. The calculation of steam quantities should be conducted on a continuous basis and should be based on international standards. The measurement results should be summarized transparently in regular production reports.

Note 2: Non-condensable gases in geothermal steam

Non-condensable gases (NCGs) in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarbons, including predominantly CH_4. In geothermal power projects, NCGs flow with the steam into the power plant. A small proportion of the CO_2 is converted to carbonate / bicarbonate in the cooling water circuit. In addition, parts of the NCGs are reinjected into the geothermal reservoir. However, as a conservative approach, this methodology assumes that all NCGs entering the power plant are discharged to atmosphere via the cooling tower. NCG sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2 - Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only). The CO_2 and CH_4 sampling and analysis procedure consists of collecting NCG samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. Hydrogen sulphide (H_2S) and carbon dioxide (CO_2) dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane. The NCG sampling and analysis should be performed at least every three months and more frequently, if necessary.

Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

The table has been left empty as it can only be filled when referring to the specific project circumstances. In a standard case of a renewable energy project, leakage is not likely to occur.

ID number	Data type	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment

Quality control (QC) and quality assurance (QA) procedures

All variables, except one related to off-site transportation, used to calculate project and baseline emissions are directly measured or are publicly available official data. To ensure the quality of the data, in particular those that are measured, the data are double-checked against commercial data. The quality control and quality assurance measures planned for the Project are outlined in the following table.

Default data (for emission factors) and International Energy Agency (IEA) statistics (for energy data) are used to check the local data.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
1; 2	Low	Yes	These data will be directly used for calculation of emission reductions. Sales record to the grid and other records are used to ensure the consistency.
other	Low	Yes	Default data (for emission factors) are used to check the local data.

What are the potential strengths and weaknesses of this methodology?

Strengths are that the methodology is transparent, simple and cost-effective for the project developer