Approved consolidated baseline and monitoring methodology ACM0007

"Consolidated methodology for conversion from single cycle to combined cycle power generation"

I. SOURCE AND APPLICABILITY

Sources

This consolidated baseline and monitoring methodology is based on elements from the following methodologies:

- NM0070: Conversion of existing open cycle gas turbine to combined cycle operation at Guaracachi power station, Santa Cruz, Bolivia whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by KPMG, London;
- NM0078-rev: Conversion of single cycle to combined cycle power generation, Ghana whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Quality Tonnes and The Energy Foundation.

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

- "Tool to calculate the emission factor for an electricity system";
- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool to determine the remaining lifetime of equipment";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the CDM Executive Board (the 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"

or

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Applicability

This methodology applies to project activities that utilize previously-unused[1] waste heat from a power plant, with a single-cycle capacity, be it a gas turbine or an internal combustion engine and utilize the heat to produce steam for a turbine – thus making the system combined-cycle.

[1] The fact that heat streams have been previously unused is demonstrated by the project participant by providing documents such as original process diagrams and schemes from the construction of the plant or/and on-site checks if no equipment for heat recovery had been/is installed.

This methodology is applicable under the following conditions:

- Waste heat generated on site is not utilizable for any other purpose on-site;
- The project activity does not increase the lifetime of the existing gas turbine or engine during the crediting period, determined using the "Tool to determine the remaining lifetime of equipment"; (i.e. this methodology is applicable up to the end of the lifetime of existing gas turbine or engine, if shorter than crediting period);
- Project developers have access to appropriate data to estimate the combined margin emission factor, as described in the "Tool to calculate the emission factor for an electricity system", of the electricity grid to which the proposed project is connected.

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

II. BASELINE METHODOLOGY

Project boundary

The spatial extent of the project boundary encompasses the power plant at the project site and all power plants connected physically to the electricity system that the CDM project power plant is connected to. The spatial extent of the project electricity system, including issues related to the calculation of the build margin (BM) and operating margin (OM), is defined in "Tool to calculate the emission factor for an electricity system".

For the purpose of determining GHG emissions of the project activity, project participants shall include the following emissions sources:

- CO_2 emissions from on-site fuel consumption of fossil fuels for operation of the gas turbine or engine; and
- CO_2 emissions from on-site fuel consumption, to supplement the waste heat generated from gas turbine or engine, in generating steam to operate the steam turbine.

For the purpose of determining the baseline, project participants shall include the following emission sources:

- CO_2 emissions from fossil fuel fired power plants connected to the electricity system and in the operating and build margin;
- CO_2 emissions from operation of project power plant in open cycle mode.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

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

	Source	Gas	Included?	Justification / Explanation
Baseline Scenario	Baseline: Grid electricity generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	On-site fossil fuel consumption to operate project power plant in open cycle mode.	CO_2	Yes	An important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
Project Activity	On-site fossil fuel consumption to operate the gas turbine or engine of project power plant.	CO_2	Yes	An important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	On-site fossil fuel consumption to supplement waste heat in operating Steam turbine.	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small

Procedure for the selection of the baseline scenario and the demonstration of additionality

Project participants shall identify the most plausible baseline scenario and demonstrate additionality using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality" agreed by the Board, available at the UNFCCC CDM web site.[2]

In applying the tool, realistic and credible alternatives should be separately determined regarding how power would be generated in the absence of the CDM project activity.

In evaluating the identified alternative baseline scenarios for their compliance with applicable regulations in the framework of the Combined Tool, the following regulations should be taken into account *inter alia*:

- Regulations for utilization of waste heat on the premises where it is generated;
- Regulation on energy efficiency norms for power projects; and
- Emission norms for power projects.

Alternatives that are not in compliance with existing regulations should be removed from further assessment.

When the current practice condition (to continue the operation in open cycle) is assessed, the future estimated load factor should reflect the changes due to new conditions in the grid, analyzing the last plants that have been incorporated in the grid.

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

Project proponents, if undertaking investment analysis, shall include the revenue generated from the possible increase in electricity produced from the open cycle component in the project situation.

This methodology is only applicable where it can be demonstrated that the baseline scenario is the continuation of the current practice, i.e. that in the absence of the proposed project activity the electricity, to meet the demand in the grid system, will be generated:

(1) By the operation of the existing power plant in open cycle mode;

(2) By the operation of existing grid-connected power plants; and

(3) By the addition of new generation sources to the grid.

Emission Reduction

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(1)}$$

Where:

ER_y	=	Emissions reductions in year *y* (tCO_2)
BE_y	=	Baseline emissions in year *y* (tCO_2)
PE_y	=	Project emissions in year *y* (tCO_2)
LE_y	=	Leakage emissions in year *y* (tCO_2)

Project emissions

Project emissions (PE_y) should be calculated based on "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" and is referred to in the Tool as $PE_{FC,j,y}$, making the element processes j correspond to the combustion of fossil fuels in year *y* to operate the gas turbine or engine and to operate the steam turbine.

Baseline emissions

The baseline scenario is the following: electricity would be generated by the operation of the power plant in open cycle mode, and by grid-connected power plants. The baseline emissions for year *y* (with assumption made regarding the baseline situation) are calculated as follows:

$$BE_{X,y} = EF_{OC} \times EG_{OC,X,y} + EF_{grid,y} \times (EG_{CC,y} - EG_{OC,X,y}) \quad \textbf{(2)}$$

Where:

EF_{OC}	=	Emission factor for plant operational in Open Cycle Mode (tCO_2/MWh)
$EG_{OC,X,y}$	=	Electricity generated by the open cycle in the baseline (MWh); as shown below, this is calculated in two ways based on historical data ($EG_{OC,H,y}$), or based on the load factor in the project plant ($EG_{OC,P,y}$) and Index *X* is either "*H*" or "*P*"
$EG_{CC,y}$	=	Actual electricity generated by project in year *y* (MWh)
$EF_{grid,y}$	=	CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)

If more than one fuel is used in the gas turbine or engine, the baseline calculation (equation 2) must assume the emission factor of the least carbon intensive fuel that has been used before or after project implementation.

Step 1: Estimating $EG_{OC,X,y}$

Project participants shall estimate, by the two ways provided below, the amount of generation by the power plant running in open cycle mode in the baseline (MWh). The calculation is done based on: (i) The historic load situation ($EG_{OC,H,y}$) and for (ii) The load situation in the project ($EG_{OC,P,y}$), as follows:

(i) Amount of baseline power generation assuming on historical data (MWh):

$$EG_{OC,H,y} = \mathrm{E}G_{OC} \quad \textbf{(3)}$$

Where:

EG_{OC} = Average net annual generation from the operation of power plant in open cycle mode based on five years of generation records at the time of validation (MWh). If five years data is not available, then data for the highest number of complete years available should be used, with a minimum of three full years

(ii) And amount of baseline power generation calculated assuming load situation of project power plant (MWh):

$$EG_{OC,P,y} = \frac{Cap_{OC}}{Cap_{CC}} \times EG_{CC,y} \quad \textbf{(4)}$$

Where:

Cap_{OC} = Net power generation capacity[3] of the open cycle gas turbine or engine before the project activity (MW)

$EG_{CC,y}$ = Actual electricity generated by project in year *y* (MWh)

Cap_{CC} = Net installed power generation capacity (MW) of the project including both the open cycle (gas turbine or engine) and the steam turbine capacity

Step 2: Estimating EF_{OC}, the emissions factor for electricity generated in open cycle mode in the baseline

The emissions factor for the open cycle mode generation in the baseline (EF_{OC} in tCO_2/MWh) is given by historical performance of the plant when it operated in open cycle using data for five years at the time of validation. The emission factor is calculated as follows:

$$EF_{OC} = \frac{FC_{HIST}}{EG_{OC}} \times NCV \times EF_{CO2} \quad \textbf{(5)}$$

[3] Net capacity is defined as gross capacity less auxiliary consumption of the plant.

Where:

FC_{HIST} = Annual average fuel consummation of the open cycle gas turbine or engine (mass or volume unit) estimated using data for five years at the time of validation. If five years data is not available, then data for the highest number of complete years available should be used, with a minimum of three full years

EG_{OC} = Average net annual generation from the operation of power plant in open cycle mode (MWh)

NCV = Net calorific value of the fuel(GJ/mass or volume unit)

EF_{CO2} = CO_2 emission factor of the fuel (tCO_2/GJ)

Step 3: Determine the emissions factor for the operating margin

The baseline emission factor ($EF_{grid,y}$) should be calculated as a combined margin (CM), following the guidance in the "Tool to calculate the emission factor for an electricity system".

If project proponents use the dispatch data analysis method, as described in the "Tool to calculate the emission factor for an electricity system", the following modification applies:

The group *n* of power plants in the dispatch margin is set of power plants in the top x% of total electricity dispatched by the grid system during hour *h*, where x% is equal to the greater of either:

- 10%; or
- The project generation during hour *h* expressed as a percentage of the total grid generation for that hour.

Project proponents can use the efficiency of the plant to estimate combined margin emission factor if fuel data for plants is not available. The volume of fuel consumed by each plant can be calculated using the efficiency of the plant and the electricity output. The efficiencies of the units attached to the grid should be from publicly verifiable sources. In case of multiple sources and values of efficiency one which results in most conservative estimate of emission factor should be used.

Step 4: Conservatively determine baseline emissions

The baseline emission BE_y for year *y* is the lower value between the baseline emissions calculated on the basis of historical power generation, $BE_{H,y}$, and the baseline emissions calculated based on the load factor of the project situation, $BE_{P,y}$:

$$BE_y = MIN(BE_{H,y}, BE_{P,y}) \quad \textbf{(6)}$$

Where $BE_{H,y}$, and $BE_{P,y}$ are determined with equations (2) to (5).

Leakage

The main emissions potentially giving rise to leakage in the context of the proposed projects are:

(i) CH_4 leakage in production, transportation and consumption of increased quantity of natural gas consumed by the project activity; and

(ii) Emissions arising due to power plant construction.

The CH_4 emissions can be ignored while applying this methodology, if project proponents demonstrate through estimation that these are a negligible fraction of baseline.

Project participants do not need to consider construction related emission sources as leakage in applying this methodology. Project activities using this baseline methodology shall not claim any credit for the project on account of reducing these emissions below the level of the baseline scenario.

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter:	EG_{OC}
Data unit:	MWh
Description:	Historical net quantity of electricity generated by the Open Cycle operation of power plant
Source of data:	Generation records. Historical data of electricity supplied by the project to the grid, preferably for five year should be used and not less than three years
Measurement procedures (if any):	
Any comment:	The consistency of metered net electricity generation should be cross-checked with receipts from sales (if available). Meters should be subject to regular maintenance and testing regime to ensure efficiency

Data / Parameter:	Cap_{OC}
Data unit:	MW
Description:	Net power generation capacity[4] of the open cycle gas turbine or engine (before the project activity)
Source of data:	Manufacturer's specification
Measurement procedures (if any):	
Any comment:	

Data / Parameter:	Cap_{CC}
Data unit:	MW
Description:	Net generation capacity of the project power plant
Source of data:	Manufacturer's specification
Measurement procedures (if any):	
Any comment:	

[4] Net capacity is defined as gross capacity less auxiliary consumption of the plant.

Data / Parameter:	FC_{HIST}
Data unit:	Mass or Volume
Description:	Historic Fuel consumption of the project in Open cycle generation
Source of data:	Historical data of annual fuel consumption by the project operating in open cycle mode
Measurement procedures (if any):	
Any comment:	The data for any direct measurements with mass or volume meters at the plant site should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes. Meters should be subject to regular maintenance and testing regime to ensure efficiency

Data / Parameter:	NCV
Data unit:	GJ / mass or volume unit
Description:	Net calorific value of fossil fuel type used previous to the start of project
Source of data:	The following data sources may be used if the relevant conditions apply:

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 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If (a) is not available

Measurement procedures (if any):	For (a) and (b): measurements should be undertaken in line with national or international fuel standards. The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated
	For (c): review appropriateness of the values annually
	For (d): any future revision of the IPCC Guidelines should be taken into account

Any comment:	If more than one fuel is used in the gas turbine or engine, the NCV of the least carbon intensive fuel that has been used before or after project implementation, should be determined. 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

Data / Parameter:	EF_{CO2}
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for fossil fuel used previous to the start of project
Source of data:	The following data sources may be used if the relevant conditions apply:

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

Measurement procedures (if any):	For (a) and 9b): measurements should be undertaken in line with national or international fuel standards. The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated
	For (c): review appropriateness of the values annually
	For (d): any future revision of the IPCC Guidelines should be taken into account

Any comment:	If more than one fuel is used in the gas turbine or engine, the emission factor of the least carbon intensive fuel that has been used before or after project implementation, should be determined. Verify if the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.3, 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

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent 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.

Data and parameters monitored

Data / Parameter:	$EG_{CC,y}$
Data unit:	MWh
Description:	Net quantity of electricity generated by the project power plant in year *y*
Source of data:	Manufacturer's specification
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net electricity generation should be cross-checked with receipts from sales (if available). Meters should be subject to regular maintenance and testing regime to ensure efficiency.
Any comment:	

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History of the document

Version	Date	Nature of Revision
04	EB 55, Annex 11 30 July 2010	• Annual average fuel consumption of the open cycle gas turbine or engine may be estimated using data from five years previous to start of the project at the time of validation. If five years data is not available, then data for the highest number of complete years available, but not less than three, should be used; • References to "Tool to determine the remaining lifetime of equipment" and "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" were added; • The format of the methodology was updated.
03	EB 35, Paragraph 24 02 November 2007	The reference to ACM0002 was replaced by a reference to “Tool to calculate the emission factor for an electricity system”.
02	EB 31, Annex 9 02 May 2007	The applicability of the approved methodology was expanded to single cycle engine systems.
01	EB 22, Annex 9 28 November 2005	Initial adoption.
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