Draft revision to the approved consolidated baseline and monitoring methodology ACM0011

"Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation"

I. SOURCE AND APPLICABILITY

Source

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

- NM0200 "Baseline methodology for fuel switching from coal and/or petroleum fuel (high carbon intensive) to natural gas (low carbon intensive) in a grid connected/stand alone power generation facility" prepared by Lanco Kondapally Power Private Limited, India.
- NM0213 "Fuel Switch to less carbon content fuel for power generation which is used for captive power and is not connected to the grid " prepared by Asia Carbon Pte Ltd., Singapore.
- NM0226 "Fuel switching from naphtha to natural gas at grid-connected power generation facility of GIPCL, in Vadodara, Gujarat" prepared by Gujarat Industries Power Company Ltd (GIPCL) and PricewaterhouseCoopers Pvt Ltd.

For more information regarding the proposals and their consideration by the Executive Board please refer to https://cdm.unfccc.int/methodologies/approved.

This methodology refers to the latest version of the:

- "Tool for the demonstration and assessment of additionality";
- "Combined tool for identification of baseline scenario and demonstration of additionality";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

Please refer to: https://cdm.unfccc.int/goto/MPappmeth.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

Definitions

Project activity power plant (PAPP). An existing power plant where the fuel switch project activity is implemented.

~~Captive consumer - captive consumer is defined as a consumer or multiple consumers, connected through a local grid, of electricity that are supplied electricity from PAPP alone.~~
Captive consumer(s). Captive consumer(s) is/are defined as a consumer or multiple consumers that are supplied with electricity from the PAPP alone and that are either located directly at the site of the PAPP or are connected through (a) dedicated electricity line(s) with the PAPP but not via the electricity grid.

Electricity grid. Electricity grid is an electricity supply system to which many consumers and many power plants are connected, as defined in ACM0002. The power plants connected to the electricity

supply system are dispatched by a dispatch center. Localized grids, i.e. grids in which a limited number of power plants not dispatched by a dispatch center are connected, are excluded from this definition.

Applicability

This methodology is applicable to project activities that switch from coal and/or petroleum fuels to natural gas in an existing power plant for electricity generation with an operation history of at least three years. The following conditions apply:

- The PAPP either supplies electricity only to the electricity grid (refer to the definition above) or only to a captive consumer (refer to the definition above);
- Under the project activity, only natural gas is used in the PAPP except for auxiliary fuel consumption (e.g., for start-ups) which shall not exceed one percent of the total fuel consumption in the PAPP (measured on an energy basis);
- Prior to the implementation of the project activity, only coal and/or petroleum fuels (but not natural gas) were used in the PAPP to generate electricity;
- Coal/petroleum fuel is available in the country/region for electricity generation;
- Regulations/laws and programs do neither restrain the facility from using the fossil fuels used prior to implementing the project activity nor require the use of natural gas or a specified fuel to generate electricity;
- The captive consumer or electricity grid, to which the electricity generated by the PAPP is sold, if applicable, is not restrained by regulations/law to purchase electricity generated from different type of fuels, i.e. it is not prohibited to purchase electricity generated using a higher GHG intensity fuel during the crediting period of the project activity.
- The project activity does not involve major retrofits/modifications of the power plant other than the fuel switch, for instance the removal of existing technology and installation of new technology such as new gas turbines, new combine cycle gas power generation, etc.;
- The project activity does not result in a significant change in the power generation capacity, i.e. not more than ~~□~~±5% of the installed power generation capacity before the implementation of the project activity;
- ~~□ The project activity does not result in an increase of the lifetime of the PAPP during the crediting period. If the lifetime of the PAPP is increased due to the project activity, the crediting period shall be limited to the estimated remaining lifetime of the power plant, i.e. the time when the existing power plant would need to be replaced in the absence of the project activity;~~
- This methodology is only applicable if the most plausible baseline scenario is the continuation of the use of high carbon intensive fuels like coal and/or petroleum fuels for electricity generation in the PAPP.

The methodology is **not** applicable in the following situations:

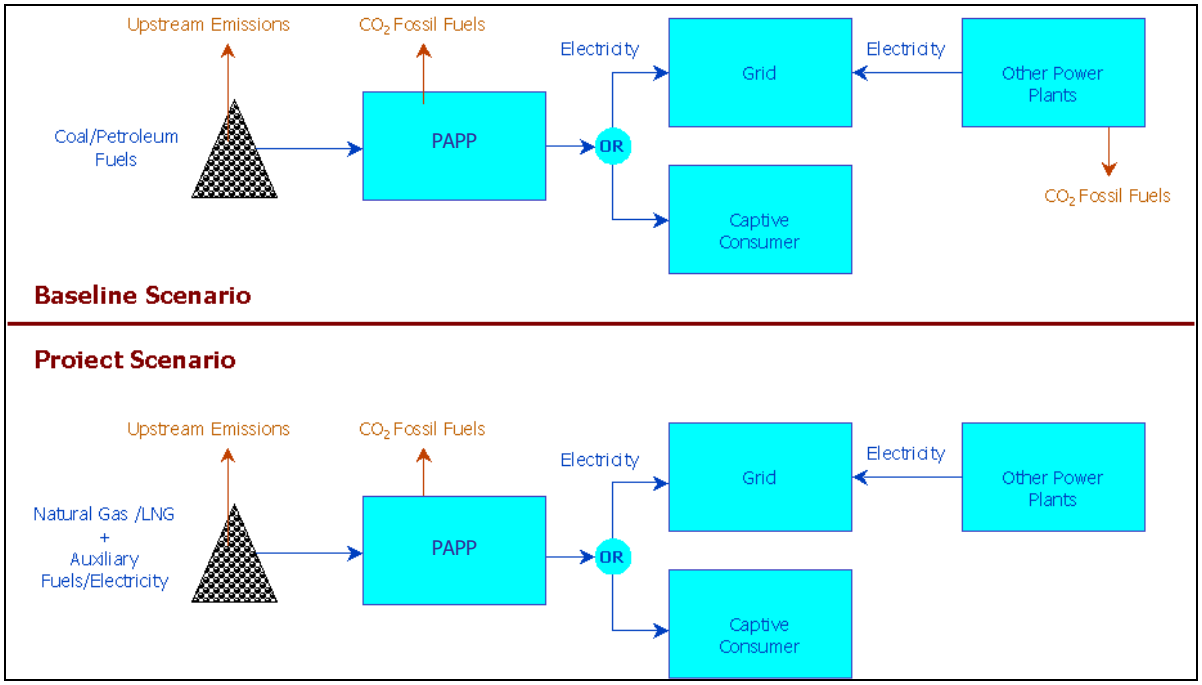
- Greenfield power plants that would have used a higher GHG intensity fuel in absence of CDM benefits;[1]
- This methodology is neither applicable to fuel switch for cogeneration projects nor to energy efficiency improvement projects;

II. BASELINE METHODOLOGY

Project boundary

The project boundary encompasses the PAPP and, where applicable, the power plants connected to the grid to which the PAPP is connected or the captive consumers that are supplied with the project activity power plant. Emissions sources and gases are listed in Table 1 and the project boundary is described in Figure 1.

Figure 1: Project boundary

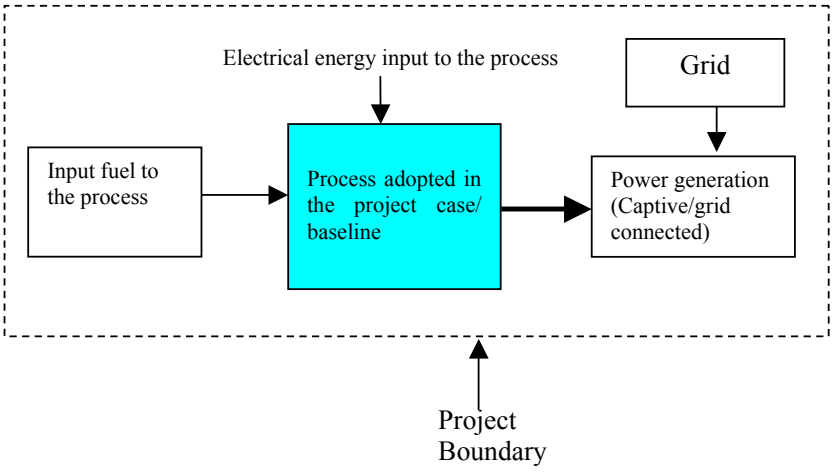


[1] Such project activities may use approved methodology AM0029, if they meet the applicability requirements of the approved methodology.

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

	Source	Gas	Included?	Justification/Explanation
Baseline	Emissions due to the combustion of the baseline fuel (coal and/or petroleum fuels) for electricity production in the PAPP	CO_2	Yes	Main emission source
		CH_4	No	Minor source
		N_2O	No	Minor source
	Emissions due to the combustion of fossil fuels in grid connected power plants	CO_2	Yes	Main emission source
		CH_4	No	Minor source
		N_2O	No	Minor source
Project Activity	Emissions due to the combustion of natural gas for electricity production in the PAPP	CO_2	Yes	Main emission source
		CH_4	No	Minor source
		N_2O	No	Minor source
	Emissions due to the use of energy (auxiliary fuel, purchased electricity etc) for the operation of the PAPP	CO_2	Yes	Main emission source
		CH_4	No	Minor source
		N_2O	No	Minor source

~~**Figure 1 - Diagram of the project boundary**~~



Procedure for estimating the remaining lifetime ~~and to determineing installed capacity~~ of the power plant

If the lifetime of the existing power plant is not prolonged as a result of the project activity, the application of this procedure is not necessary. In this case, project participants should provide appropriate explanations and documentation that the lifetime is not prolonged in the CDM-PDD.

If the lifetime of the PAPP is prolonged as a result of the project activity, the remaining lifetime of the existing power plant in the absence of the project activity should be determined. One of the following approaches ~~shall be taken into account~~ shall be used to estimate the remaining lifetime of the ~~PAPP~~existing power plant~~, i.e. the time when the PAPP would need to be replaced in the absence of the project activity~~:

a) The typical average technical lifetime of the type of the power plant may be determined taking into account common practices in the sector and country (e.g. based on industry surveys, statistics, technical literature, etc.);

b) The practices of the responsible company regarding replacement schedules may be evaluated and documented (e.g. based on historical replacement records for similar equipment);

The time of replacement of the existing power plant in the absence of the project activity should be chosen in a conservative manner, i.e. the earliest point in time should be chosen in cases where only a time frame can be estimated, and should be documented in CDM-PDD.

If the remaining lifetime of the power plant is increased due to the project activity, the crediting period has to be limited to the estimated remaining lifetime of the power plant, i.e. the time when the existing power plant would have been replaced in the absence of the project activity.

Procedure for estimating the installed capacity of the power plant

The installed capacity of the PAPP before and after the fuel switch activity shall be tested using an internationally approved standard or equivalent national standards. The DOE shall validate ~~a report on the~~ the determination of the installed capacity ~~assessment~~. If the change in installed capacity of the PAPP is more than ~~□~~±5% ~~of the installed capacity/output of the~~ PAPP, then this methodology is not applicable.

Procedure for selection of the most plausible baseline scenario

Project proponents shall determine the most plausible baseline scenario through the application of the following steps:

Step 1a. Identify all realistic and credible alternatives to the project activity

Identify all alternative scenarios that are available to the project participants and that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity, i.e. all type of options that could generate electricity with lower GHG intensity. These alternative scenarios shall include, inter alia:

– The proposed project activity undertaken without being registered as a CDM project activity;

– Power generation using the same fossil fuel, but technologies/measures other than those currently used in the PAPP that could reduce the emissions intensity of electricity generation;

– Power generation using energy sources other than that used in the project activity;

– Power generation using current energy source (coal and/or petroleum fuels), i.e. the current practice;

– The "proposed project activity undertaken without being registered as a CDM project activity" carried out at a later point in time (e.g. due to change in fuel prices, existing regulations, end-of-life of existing equipment, financing aspects).

For the purpose of identifying relevant alternative scenarios, provide an overview of other technologies or
practices used in power generation and that have been implemented previously or are currently underway in the relevant geographical area. The relevant geographical area should in principle be the host country of the proposed CDM project activity. A region within the country could be the relevant geographical area if the framework conditions vary significantly within the country. However, the relevant geographical area should include preferably ten power generation facilities. If less than ten power generation facilities are found in the region the geographical area may be expanded to an area that covers, if possible, ten such power generation facilities within the national grid boundary. In cases where the above described definition of geographical area is not suitable, the project proponents should provide an alternative definition of geographical area. Other registered CDM project activities are not to be included in this analysis. Provide relevant documentation to support the results of the analysis.

Outcome of Step 1a: List of plausible alternative scenarios to the project activity

Step 1b. Consistency with applicable laws and regulations

The alternative(s) shall be in compliance with all mandatory applicable legal and regulatory requirements,
even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution (this sub-step does not consider national and local policies that do not have legally-binding status).

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

Outcome of Step 1b: List of alternative scenarios to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and EB
decisions on national and/or sectoral policies and regulations.

Step 2. Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers should be eliminated by applying "Step 2 - Barrier analysis" of the latest version of the "Combined tool for identification of baseline scenario and demonstrate additionality" agreed by the CDM Executive Board.

– 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.

– If there are still several alternative scenarios remaining project participants may choose to either:

- Option 1: go to step 3 (investment analysis),

or

- Option 2: identify the alternative with the lowest emissions (i.e. the most conservative) as the baseline scenario.

Step 3. Comparison of economic attractiveness of the remaining alternatives

Compare the economic attractiveness without revenues from CERs for alternatives that are remaining by applying "Step 3 - Investment analysis" of the latest version of the "Combined tool for identification of baseline scenario and demonstrate of additionality" agreed by the CDM Executive Board.

The economic investment analysis shall use the net present value (NPV) analysis, and explicitly state the following parameters:

- Investment requirements (including break-up into major equipment cost, required construction work, installation);
- A discount rate appropriate to the country and sector (Use government bond rates, increased by a suitable risk premium to reflect private investment in fuel switching projects, as substantiated by an independent (financial) expert);
- Efficiency of each element process, taking into account any differences between fuels;
- Current price and expected future price (variable costs) of each fuel. Estimates of the future prices have to be substantiated by a public and official publication from a governmental body or an intergovernmental institution). If such publications are not available, highlight the key logical assumptions and quantitative factors for determining the development of costs of each fuel (e.g. international market price, transport costs, level of taxes/subsidies, local price). State clearly which assumptions and factors have significant uncertainty associated with them, and include these uncertainties in the sensitivity analysis in "Step 3 – investment analysis";
- Operating costs for each fuel (especially, handling/treatment costs for coal);
- Lifetime of the project, equal to the remaining lifetime of the existing electricity generation facility; and,
- Other operation and maintenance costs, e.g. of slag and ash disposal, environmental pollution fees etc.

The NPV calculation should take into account the residual value of the new equipment at the end of the lifetime of the project activity. Provide all the assumptions made for step 3 in the CDM-PDD.

Outcome of step 3: Ranking of the short list of alternative scenarios according to the NPV taking into account the results of the sensitivity analysis.

– If the sensitivity analysis is not conclusive, identify the alternative with the lowest emissions (i.e. the most conservative).

– If the sensitivity analysis is conclusive and confirms the result of the investment comparison analysis, then the most economically or financially attractive alternative scenario is considered as baseline scenario.

This methodology is only applicable if the most plausible baseline scenario is identified as continuation of the current practice of using coal and/or petroleum fuels in the existing power plant.

Additionality

Following steps may be used to assess additionality or project participants may use the latest "Tool for the demonstration and assessment of additionality" approved by the CDM Executive Board.

Step 1: Analysis of outcome of baseline scenario identification procedure

1. If the proposed project activity is the only alternative amongst the ones considered by the project participants that is in compliance with all mandatory regulations, as identified by applying Step 1a of baseline scenario identification procedure described in the section above, with which there is general compliance, then the proposed CDM project activity is not additional.

2. If Barrier analysis is used to identify the baseline scenario, as described in the previous section, then:

    a. 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.

    b. If the implementation of the proposed project activity without being registered as a CDM project activity is prevented by any barrier, then 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 common practice analysis step, otherwise the project activity is not additional.

3. If Investment analysis step is used to identify the baseline scenario, and if the proposed project activity undertaken without being registered as a CDM project activity is not prevented by any barrier, then:

    a. If the sensitivity analysis confirms the result of the investment comparison analysis, and it cannot be ruled out that the most economically or financially attractive alternative scenario is the "proposed project activity undertaken without being registered as a CDM project activity", then the project activity is not additional.

    b. Else, proceed to common practice analysis step.

Step 2. Common practice analysis

Demonstrate that the project activity is not common practice in the relevant country and sector by applying "Step 4 - Common practice analysis" of the latest version of the "Tool for demonstration assessment and of additionality" agreed by the CDM Executive Board. To determine the considered country/region the definition of "relevant geographical area" given in section "Procedure for the selection of the most plausible baseline scenario", Step 1a above, should be used.

Baseline emissions

~~Baseline emissions are calculated as:~~

$$~~BE_y = EL_{BL,y} \cdot EF_{elec,BL}~~ \quad ~~(1)~~$$

~~$BE_{elec,y}$~~ ~~Baseline emissions due to the generation of electricity supplied to the captive consumer/electricity grid in year y of the crediting period (tCO_2).~~

~~$EL_{,BL,y}$~~ ~~Electricity supplied to the captive consumer/electricity grid in year y of the crediting period, not exceeding the supply in absence of the project activity (MWh).~~

~~$EF_{elec,BL}$~~ ~~Emission factor for the baseline source of electricity supplied to the captive consumer/electricity (tCO_2/MWh).~~

~~Project proponents shall quantify the amount of electricity that would be supplied to the captive consumer/electricity grid in the absence of the project activity (EL_{his}), as the maximum historic annual amount of electricity over three most recent years prior to implementation of project activity. If three year data is not available, then the electricity supplied during the most recent one year prior to implementation of the project activity could be used.~~

~~$$EL_{BL,y} = \begin{cases} EL_{PR,y} & \text{if} \quad EL_{PR,y} < EL_{his} \\ EL_{his} & \text{if} \quad EL_{PR,y} \geq EL_{his} \end{cases}$$~~ ~~(2)~~

~~$EL_{PR,y}$~~ ~~Total electricity supplied to the captive consumer/electricity grid by PAPP in the project case in year y of the crediting period (MWh).~~

~~$$EF_{elec,BL} = \frac{44}{12} \cdot \frac{3.6}{1000} \cdot \frac{EF_{FF,BL}}{NCV_{FF,BL} * \eta_{BL}}$$~~ ~~(3)~~

~~$EF_{FF,BL}$~~ ~~CO_2 emission factor for the coal or petroleum fuel used in the PAPP prior to the implementation of the project activity (tC/mass or volume unit).~~

~~$NCV_{FF,BL}$~~ ~~Net calorific value of fossil fuel used in the PAPP prior to implementation of the project activity. (TJ/mass or volume unit)~~

~~η_{BL}~~ ~~Efficiency of the power plant prior to implementation of the project activity.~~

Electricity generation in the PAPP will displace the use of the coal and/or petroleum fuels in the PAPP in the absence of the project activity and can, in addition, displace electricity in the grid, if the PAPP supplies electricity to the grid and if the quantity of electricity generation is increased as result of the project activity. The calculation of baseline emissions therefore depends on whether the PAPP supplies captive consumer(s) or the grid and, in case electricity is supplied to the grid, on the extent to which electricity generation is increased beyond historical levels prior to the implementation of the project activity.

If the PAPP provides electricity to captive consumer(s), baseline emissions are calculated as follows:[2]

$$BE_y = MIN\left(EG_{PJ,y}; EG_{AVR}\right) \times EF_{BL,plant,y} \quad (1)$$

[2] In this case, baseline emissions are capped to the historical electricity generation level, as a conservative and simple approach. If the quantity of electricity supplied to captive consumers is increased beyond historical levels, it would be necessary to determine how the captive consumers would generate or obtain the increased electricity in the absence of the project activity.

Where:

BE_y = Baseline emissions in year y (tCO_2/yr)
$EG_{PJ,y}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid in year y (MWh/yr)
EG_{AVR} = Average annual quantity of electricity supplied by the project activity power plant to captive consumer(s) during the three most recent historical years prior to the implementation of the project activity (MWh/yr)
EG_{MAX} = Maximum annual quantity of electricity that could have been supplied to the captive consumer(s) by the project activity power plant prior to the implementation of the project activity (MWh/yr)
$EF_{BL,plant,y}$ = Baseline emission factor of the project activity power plant in year y, i.e. the CO_2 emissions per electricity generation if coal and/or petroleum fuels would be used as fuel in the project activity power plant (tCO_2/MWh)

If the PAPP provides electricity to the grid, the following cases are differentiated:[3]

Case a) The quantity of electricity generated in the project activity power plant ($EG_{PJ,y}$) exceeds the maximum annual quantity of electricity that the PAPP could have produced prior to the implementation of the project activity (EG_{MAX}). Baseline emissions are calculated as:

$$BE_y = EG_{AVR} \cdot EF_{BL,plant,y} + \left(EG_{MAX} - EG_{AVR}\right) \cdot \min\left(EF_{BL,plant,y}; EF_{grid,y}\right) + \left(EG_{PJ,y} - EG_{MAX}\right) \cdot EF_{grid,y} \quad (2)$$

Case b) The quantity of electricity generated in the project activity power plant ($EG_{PJ,y}$) exceeds the historic average annual generation level (EG_{AVR}) but is lower than the maximum annual quantity of electricity that the PAPP could have produced prior to the implementation of the project activity (EG_{MAX}). Baseline emissions are calculated as:

$$BE_y = EG_{AVR} \cdot EF_{BL,plant,y} + \left(EG_{PJ,y} - EG_{AVR}\right) \cdot \min\left(EF_{BL,plant,y}; EF_{grid,y}\right) \quad (3)$$

Case c) The quantity of electricity generated in the project activity power plant ($EL_{PJ,y}$) is lower or the same than the historic average annual generation level (EL_{AVR}). Baseline emissions are calculated as:

$$BE_y = EG_{PJ,y} \cdot EF_{BL,plant,y} \quad (4)$$

Where:

BE_y = Baseline emissions in year y (tCO_2/yr)
$EG_{PJ,y}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid in year y (MWh/yr)
EG_{AVR} = Average annual quantity of electricity supplied by the project activity power plant to the electricity grid during the three most recent historical years prior to the implementation of the project activity (MWh/yr)

[3] If electricity generation in the project activity power plant is increased beyond historical levels after the implementation of the project activity, it is difficult to clearly attribute whether such an increase is the result of the CDM project activity or would have occurred anyhow. If the increase is a result of the project activity, the project activity displaces grid electricity. If it is not a result a of the project activity, the use of coal or petroleum fuel in the project activity power plant is displaced. To deal with this uncertainty, in this methodology the lower emission factor between the project activity power plant fired with the baseline fuel and the grid emission factor is used, as a conservative approach.

EG_{MAX} = Maximum annual quantity of electricity that could have been supplied to the the electricity grid by the project activity power plant prior to the implementation of the project activity (MWh/yr)

$EF_{BL,plant,y}$ = Baseline emission factor of the project activity power plant in year *y*, i.e. the CO_2 emissions per electricity generation if coal and/or petroleum fuels would be used as fuel in the project activity power plant (tCO_2/MWh)

$EF_{grid,y}$ = Emission factor of the electricity grid to which the project activity power plant is connected (tCO_2/MWh)

The maximum annual amount of electricity that could have been supplied to the captive consumer / the electricity grid by the PAPP prior to the implementation of the project activity is calculated as:

$$EG_{MAX} = CAP_{max} \cdot T_{max} \quad \textbf{(5)}$$

Where:

EG_{MAX} = Maximum annual quantity of electricity that could have been supplied to the the electricity grid by the project activity power plant prior to the implementation of the project activity (MWh/yr)

CAP_{max} = Maximum power generation capacity of the PAPP prior to the implementation of the project activity (MW)

T_{max} = Maximum amount of time in which the project activity power plant could have operated at full load prior to the implementation of the project activity (hours)

The average annual amount of electricity supplied to the captive consumer/electricity grid by the PAPP prior to the implementation of the project activity is calculated as follows:

$$EG_{AVR} = \frac{\sum_{x=1}^{3} EG_{PAPP,x}}{3} \quad \textbf{(6)}$$

Where:

EG_{AVR} = Average annual quantity of electricity supplied by the project activity power plant to the electricity grid / captive consumer(s) during the three most recent historical years prior to the implementation of the project activity (MWh/yr)

$EG_{PAPP,x}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year *x* (MWh/yr)

x = Three most recent historical years prior to the implementation of the project activity

The emission factor for the PAPP prior to the implementation of project activity is calculated as:

$$EF_{BL,plant,y} = \frac{1000}{3.6} \times \frac{EF_{FF,BL}}{\eta_{PAPP}} \quad \textbf{(7)}$$

Where:

$EF_{BL,plant,y}$ = Baseline emission factor of the project activity power plant in year *y*, i.e. the CO_2 emissions per electricity generation if coal and/or petroleum fuels would be used as fuel in the project activity power plant (tCO_2/MWh)

$EF_{FF,BL}$ = CO_2 emission factor of the coal or petroleum fuel used in the PAPP prior to the implementation of the project activity (tCO_2/TJ)

η_{PAPP} = Efficiency of the project activity power plant

Treatment of different fuels being used in the baseline scenario

Note that the most plausible baseline scenario may be that several fuel types would be used in the ~~baseline~~ project activity power plant in the absence of the project activity. Where the use of several fuel types is the most plausible baseline scenario, project participants should for estimating baseline emission factor, as a conservative approach, select ~~emission factor of~~ the fuel type with the lowest CO_2 emission factor from the fuels used in the power plant during the most recent three years prior to the implementation of the project activity.

Procedure for determining the efficiency of the project activity power plant

~~The energy efficiencies have to be determined, based on measurements, for the power plants for the baseline scenario ($\eta_{BL,x}$). Efficiencies for the baseline scenario (η_{BL}) could be either measured or project participants may use manufacturer's specification of efficiency at optimum load.~~

~~If the efficiency is measured, all measurements should be conducted at a range of load factor (or operation mode) that is representative of the situation during the project activity. Measurements should be carried out following national or international standards. Where a representative load factor (or operation mode) can not be determined, measurements should be conducted for different load factors (or operation modes) and be weighted by the time these load factors (or operation modes) are typically operated.~~

~~The values determined for η_{BL} should be documented in the CDM PDD and shall remain fixed throughout the crediting period.~~

The energy efficiency of the project activity power plant (η_{PAPP}) should be determined for each year *y* as the higher value between:

- The efficiency of the project activity power plant prior to the implementation of the project activity ($\eta_{PAPP,hist}$), which may be determined using one of the following options:
  - Use the manufacturer's specification of efficiency at optimum load (if no retrofit has been undertaken that results in an increased efficiency);
  - Measurements using national or international standards.
  - Determine the average historical efficiency during the most recent ~~year~~ three years prior to the implementation of the project activity, based on fuel consumption and electricity generation data, as follows:

$$\eta_{PAPP,hist} = \frac{3.6}{1000} \times \frac{\sum_{x=1}^{3} \sum_{i} FC_{i,x} \times NCV_{i,x}}{\sum_{x=1}^{3} EG_{PAPP,x}} \quad (8)$$

Where:

$\eta_{PAPP,hist}$ = Efficiency of the project activity power plant prior to the implementation of the project activity

$FC_{i,x}$ = Quantity of fossil fuel type i combusted in the project activity power plant in year *x* (mass or volume unit)

$NCV_{i,x}$ = Net calorific value of fossil fuel type *i* in year *x* (TJ/mass or volume unit)

$EG_{PAPP,x}$ = Quantity of electricity supplied by the project activity power plant to the electricity

grid or captive consumer(s) in year x (MWh/yr)

x = Three most recent historical years prior to the implementation of the project activity

i = Fossil fuel types used in the project activity power plant in year x

- The efficiency of the project activity power plant in year y ($\eta_{PAPP,y}$), calculated as follows:

$$\eta_{PAPP,y} = \frac{3.6}{1000} \times \frac{\sum_i FC_{PAPP,i,y} \times NCV_{i,y}}{EG_{PJ,y}} \quad (9)$$

Where:

$\eta_{PAPP,y}$ = Efficiency of the project activity power plant in year y

$FC_{PAPP,i,y}$ = Quantity of fossil fuel type i combusted in the project activity power plant in year y (mass or volume unit)

$NCV_{i,y}$ = Net calorific value of fossil fuel type i in year y (TJ/mass or volume unit)

$EG_{PJ,y}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year y (MWh/yr)

The value determined for $\eta_{PAPP,hist}$, the measurement procedure, the underlying data and the assumptions used (e.g. on a representative load) should be documented and justified in the CDM-PDD. $\eta_{PAPP,hist}$ and shall remain fixed throughout the crediting period.

Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{FC,j,y} + EC_{PJ,aux,y} \cdot EF_{grid,y} \quad ~~PE_y = PE_{NG,y} + PE_{aux,y}~~ \quad (10)$$

where:

PE_y = Project emissions in year y (tCO_2)

$PE_{FC,j,y}$ = Project emissions from combustion of natural gas and auxiliary fossil fuel use in the project activity power plant in year y (tCO_2)

$EC_{PJ,aux,y}$ = Auxiliary electricity consumption by the project activity in year y (MWh)

$EF_{grid,y}$ = Emission factor of the electricity grid to which the project activity power plant is connected (tCO_2/MWh)

~~$PE_{NG,y}$ Emissions due to the combustion of natural gas for the production of electricity in year y of the crediting period (tCO_2).~~

~~$PE_{aux,y}$ Emissions due to the use of energy (fuel other than natural gas and/or electricity) in year y of the crediting period (tCO_2).~~

Project emissions from combustion of natural gas and auxiliary fossil fuel use in the PAPP ($PE_{FC,j,y}$) should be determined using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where j refers to the combustion of fossil fuels in the PAPP and, if applicable, any other fossil fuel consumption at the project site that is attributable to the project activity.

~~Emissions due to the combustion of natural gas for the production of electricity are calculated as:~~

~~$$PE_{NG,y} = \frac{44}{12} \cdot NG_y \cdot EF_{NG,y}$$~~ ~~(5)~~

~~NG_y~~ ~~Total amount of natural gas used in the project power plant in year *y* of the crediting period (mass or volume units).~~

~~$EF_{NG,y}$~~ ~~CO_2 emission factor of natural gas (tC/mass or volume).~~

~~If small amounts of other fossil fuels and/or the grid electricity is used in project activity to serve auxiliary and back-up loads, corresponding emissions shall be accounted as follows.~~

~~$$PE_{aux,y} = \frac{44}{12} \cdot \sum_i \left(FF_{aux,i,y} \cdot EF_i \right) + EL_{aux,grid,y} \cdot EF_{elec,y}$$~~ ~~(6)~~

~~$FF_{aux,i,y}$~~ ~~Total amount of fossil fuel *i* used in the project power plant to serve auxiliary and back-up loads in year *y* of the crediting period (mass or volume units).~~

~~EF_i~~ ~~CO_2 emission factor of fossil fuel *i* (tC/mass or volume unit).~~

~~$EL_{aux,grid,y}$~~ ~~Electricity used in the project power plant to serve auxiliary and back-loads that is obtained from the grid, if any (MWh).~~

~~$EF_{elec,y}$~~ ~~Combined margin emission factor for the grid electricity to which the project activity is connected calculated as per the latest version of ACM0002, using 50/50 OM/BM weight (tCO_2/MWh), or a conservative default value of 1.3 tCO2/MWh may be used.~~

Leakage

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered:[4]

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of (a) natural gas / auxiliary fossil fuels used in the project activity power plant under the project activity, (b) fossil fuels used in the project activity power plant in the absence of the project activity and, if the project displaces grid electricity, (c) fossil fuels used in the grid in the absence of the project activity.
- In the case LNG is used in the project plant: CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y} \quad \textbf{(11)}$$

[4] The Meth Panel is undertaking further work on the estimation of leakage emission sources in case of fuel switch project activities. This approach may be revised based on outcome of this work.

Where:

LE_y = Leakage emissions during the year y (tCO_2e)
$LE_{CH4,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions in the year y (tCO_2e)
$LE_{LNG,CO2,y}$ = Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y (tCO_2)

Note that to the extent that upstream emissions occur in Annex I countries that have ratified the Kyoto Protocol, from 1 January 2008 onwards, these emissions should be excluded, if technically possible, in the leakage calculations.

Fugitive methane emissions

For the purpose of determining fugitive methane emissions associated with the production – and in case of natural gas, the transportation and distribution of the fuels – project participants should multiply the quantity of natural gas consumed in the project activity power plant with a methane emission factor for these upstream emissions, and subtract, for all fuel types i which would be used in the absence of the project activity, the fuel quantities multiplied with respective methane emission factors, as follows:

$$LE_{CH4,y} = \left[\sum_i FC_{PAPP,i,y} \times NCV_{i,y} \times EF_{CH4,upstream,i} - LE_{CH4,BL,y} \right] \cdot GWP_{CH4} \quad (12)$$

Where:

$LE_{CH4,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions in the year y (tCO_2e)
$FC_{PAPP,i,y}$ = Quantity of fossil fuel type i combusted in the project activity power plant in year y (mass or volume unit)
$NCV_{i,y}$ = Net calorific value of fossil fuel type i in year y (TJ/mass or volume unit)
$EF_{CH4,upstream,i}$ = Emission factor for upstream fugitive methane emissions from production, transportation and distribution of fuel type i (tCH_4/TJ)
$LE_{CH4,BL,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions from using fossil fuels in the absence of the project activity in the year y (tCO_2e)
GWP_{CH4} = Global warming potential of methane valid for the relevant commitment period
i = Fossil fuel types used in the project activity power plant in year y (natural gas and, if applicable, auxiliary fuel consumption)

The calculation of fugitive methane emissions that would occur in the absence of the project activity ($LE_{CH4,BL,y}$) depends on whether electricity is supplied to captive consumers or the electricity grid and on which of the cases a), b) or c), as described under baseline emissions, applies, as follows:

- The fugitive upstream CH_4 emissions in the absence of the project ($LE_{CH4,BL,y}$) are calculated based on the coal or petroleum fuel type that was used in the project activity power plant prior to the implementation of the project activity. This is the case if
  - the PAPP supplies electricity to captive consumer(s); or
  - the PAPP supplies electricity to the grid and case c) applies; or
  - the PAPP supplies electricity to the grid, case b) applies, and $EF_{BL,plant,y} < EF_{grid,y}$.

  In these cases, $LE_{CH4,BL,y}$ is calculated as follows:

$$LE_{CH4,BL,y} = EG_{PJ,y} \times \frac{1000}{3.6} \times \frac{EF_{CH4,upstream,BL}}{\eta_{PAPP}} \quad (13)$$

Where:

$LE_{CH4,BL,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions from using fossil fuels in the absence of the project activity in the year y (tCH_4/yr)

$EG_{PJ,y}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year y (MWh/yr)

$EF_{CH4,upstream,BL}$ = Emission factor for upstream fugitive methane emissions from production, transportation and distribution of the coal or petroleum fuel used in the PAPP prior to the implementation of the project activity (tCH_4/TJ)

η_{PAPP} = Efficiency of the project activity power plant

- The fugitive upstream CH_4 emissions in the absence of the project ($LE_{CH4,BL,y}$) are calculated based on the coal or petroleum fuel type that was used in the project activity power plant prior to the implementation of the project activity and based on the fossil fuel types that would be used in grid-connected power plants in the absence of the project activity. This is the case if

  - the PAPP supplies electricity to the grid and case a) applies; or
  - the PAPP supplies electricity to the grid, case b) applies, and $EF_{BL,plant,y} > EF_{grid,y}$.

  In these cases, $LE_{CH4,BL,y}$ is calculated as follows:

  If $EF_{BL,plant,y} > EF_{grid,y}$:

$$LE_{CH4,BL,y} = EG_{AVR} \times \frac{1000}{3.6} \times \frac{EF_{CH4,upstream,BL}}{\eta_{PAPP}} + \left(EG_{PJ,y} - EG_{AVR}\right) \times EF_{CH4,upstream,grid} \quad (14)$$

  If $EF_{BL,plant,y} < EF_{grid,y}$:

$$LE_{CH4,BL,y} = EG_{MAX} \times \frac{1000}{3.6} \times \frac{EF_{CH4,upstream,BL}}{\eta_{PAPP}} + \left(EG_{PJ,y} - EG_{MAX}\right) \times EF_{CH4,upstream,grid} \quad (15)$$

Where:

$LE_{CH4,BL,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions from using fossil fuels in the absence of the project activity in the year y (tCO_2e)

$EG_{PJ,y}$ = Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year y (MWh/yr)

EG_{AVR} = Average annual quantity of electricity supplied by the project activity power plant to the electricity grid during the three most recent historical years prior to the implementation of the project activity (MWh/yr)

EG_{MAX} = Maximum annual quantity of electricity that could have been supplied to the the electricity grid by the project activity power plant prior to the implementation of the project activity (MWh/yr)

$EF_{CH4,upstream,BL}$ = Emission factor for upstream fugitive methane emissions from production, transportation and distribution of the coal or petroleum fuel used in the PAPP prior to the implementation of the project activity (tCH_4/TJ)

$EF_{CH4,upstream,grid}$ = Emission factor for upstream fugitive methane emissions from production, transportation and distribution of the fossil fuel types that are used in grid-connected power plants in the absence of the project activity (tCH_4/MWh)

η_{PAPP} = Efficiency of the project activity power plant

$$LE_{CH4,y} = \left[NG_y \cdot NCV_{NG,y} \cdot EF_{NG,upstream,CH4} - \frac{EL_{BL,y}}{\eta_{BL}} \cdot NCV_{FF,y} \cdot EF_{FF,upstream,CH4} \right] \cdot GWP_{CH4} \quad (8)$$

$LE_{CH4,y}$ Leakage emissions due to upstream fugitive CH_4 emissions in the year *y* (tCO_2).

NG_y Total amount of natural gas used in the project power plant in year *y* of the crediting period (mass or volume units).

$NCV_{NG,y}$ Net calorific value of natural gas, referred to in the same basis (pressure and temperature) as NG_y (TJ/mass or volume units).

$EF_{NG,upstream,CH4}$ Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas (tCH_4/TJ).

$EL_{elec,BL,y}$ Electricity supplied to the captive consumer/electricity grid in year *y* of the crediting perido up to the level of baseline supply (MWh).

$\eta_{BL,y}$ Efficiency of the power plant in the baseline as function of the load factor of the project activity power plant in year *y* of the crediting period.

$NCV_{i,y}$ Net calorific value of fossil fuel type *i* (TJ/mass or volume units).

$EF_{i,upstream,CH4}$ Emission factor for upstream fugitive methane emissions from production of the fuel type *i* (a coal or petroleum fuel type) (tCH_4/TJ).

GWP_{CH4} Global warming potential of methane valid for the relevant commitment period.

Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH_4 emissions by the quantity of fuel produced or supplied respectively[5]. Where such data is not available, project participants may use the default values provided in Table 2 below. In this case, the natural gas emission factor for the location of the project should be used, except in cases where it can be shown that the relevant system element (gas production and/or processing/transmission/distribution) is predominantly of recent vintage and built and operated to international standards, in which case the US/Canada values may be used.

Note that the emission factor for fugitive upstream emissions for natural gas ($EF_{NG,upstream,CH4}$) should include fugitive emissions from production, processing, transport and distribution of natural gas, as indicated in the Table 2 below. Note further that in case of coal the emission factor is provided based on a mass unit and needs to be converted in an energy unit, taking into account the net calorific value of the coal.

[5] GHG inventory data reported to the UNFCCC as part of national communications can be used where country-specific approaches (and not IPCC Tier 1 default values) have been used to estimate emissions.

~~Table 2: Default emission factors for fugitive CH_4 upstream emissions~~

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
Coal			
Underground mining	t CH4 / kt coal	13.4	Equations 1 and 4, p. 1.105 and 1.110
Surface mining	t CH4 / kt coal	0.8	Equations 2 and 4, p.1.108 and 1.110
Oil			
Production	t CH4 / PJ	2.5	Tables 1-60 to 1-64, p. 1.129 - 1.131
Transport, refining and storage	t CH4 / PJ	1.6	Tables 1-60 to 1-64, p. 1.129 - 1.131
Total	t CH4 / PJ	4.1	
Natural gas			
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
~~Processing, transport and distribution~~	~~t CH4 / PJ~~	~~88~~	~~Table 1-60, p. 1.129~~
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

CO_2 emissions from LNG

Where applicable, CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO2,y}$) should be estimated by multiplying the quantity of natural gas combusted in the project with an appropriate emission factor, as follows:

~~$LE_{LNG,CO2,y} = NG_y \cdot NCV_{NG,y} \cdot EF_{CO2,upstream,LNG}$~~

$$LE_{LNG,CO2,y} = FC_{PAPP,NG,y} \cdot NCV_{NG,y} \cdot EF_{CO2,upstream,LNG} \quad \textbf{(16)}$$

where:

$LE_{LNG,CO2,y}$ = Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y (tCO_2)

~~NG_y~~ $FC_{PAPP,NG,y}$ = Total amount of natural gas used in the project activity power plant in year y (mass or volume unit)

$NCV_{NG,y}$ = Net calorific value of natural gas in year y, referred to in the same basis (pressure and temperature) as $FC_{PAPP,NG,y}$ ~~NG_y~~ (TJ/mass or volume unit)

$EF_{CO2,upstream,LNG}$ = Emission factor for upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system (tCO_2/TJ)

~~Where reliable and accurate data on upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system are available, project participants should use this data to determine an average emission factor. Where such data is not available, project participants may assume a default value of 6 tCO_2/TJ as a rough approximation[6].~~

Emission reductions

Emissions reduction by the project activity during a given year *y* are the difference between the baseline emissions, project emissions and leakage emissions, as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(17)}$$

where:

ER_y	Emission reductions during the year *y* (tCO_2e/yr)
BE_y	Baseline emissions during the year *y* (tCO_2/yr)
PE_y	Project emissions during the year *y* (tCO_2/yr)
LE_y	Leakage emissions during the year *y* (tCO_2e/yr)

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

At the start of the second and third crediting period project proponents have to address two issues:

- Assess the continued validity of the baseline; and,
- Update the baseline.

In assessing the continued validity of the baseline, a change in the relevant national and/or sectoral regulations between two crediting periods has to be examined at the start of the new crediting period. If at the start of the project activity, the project activity was not mandated by regulations, but at the start of the second or third crediting period regulations are in place that enforce the practice or norms or technologies that are used by the project activity, the new regulation (formulated after the registration of the project activity) has to be examined to determine if it applies to existing plants or not. If the new regulation applies to existing CDM project activities, the baseline has to be reviewed and, if the regulation is binding, the baseline for the project activity should take this into account. This assessment will be undertaken by the verifying DOE.

For updating the baseline at the start of the second and third crediting period, new data available will be used to revise the baseline scenario and emissions. In particular fuel and other prices are to be reconsidered and present and future prices have to be determined for the investment analysis.

Project participants shall assess and incorporate the impact of new regulations on baseline emissions.

[6] This value has been derived on data published for North American LNG systems. "Barclay, M. and N. Denton, 2005. Selecting offshore LNG process. http://www.fwc.com/publications/tech_papers/files/LNJ091105p34-36.pdf (10th April 2006)".

Data and parameters not monitored

In addition to the parameters listed below, the provisions on "data and parameters not monitored" in the latest approved version of the following tools apply:

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

Parameter:	$EG_{PAPP,x}$
Data unit:	MWh/yr
Description	Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year *x,* where *x* are the three most recent historical years prior to the implementation of the project activity
Source of data:	Data logs at the project activity power plant
Measurement procedures (if any):	-
Any comment:	-

Parameter:	$FC_{i,x}$
Data unit:	mass or volume unit
Description	Quantity of fossil fuel type i combusted in the project activity power plant in year x, where *x* are the three most recent historical years prior to the implementation of the project activity
Source of data:	Data logs at the project activity power plant
Measurement procedures (if any):	-
Any comment:	-

~~Parameter:~~	~~EL_{his}~~
~~Data unit:~~	~~MWh~~
~~Description~~	~~Electricity supplied to the captive consumer/electricity grid in the absence of the project activity~~
~~Source of data:~~	~~Electricity meters at the project site.~~
~~Measurement procedures (if any):~~	~~Read electricity meters and record information.~~
~~Any comment:~~	~~Defined as the maximum historic annual electricity supplied to the grid/captive consumer over three most recent years prior to implementation of project activity. If three year data is not available, then the electricity supplied during the most recent one year prior to implementation of the project activity could be used.~~

Parameter:	$\eta_{BL,PAPP,hist}$
Data unit:	~~fraction~~
Description	Efficiency of ~~the~~ PAPP prior to the implementation of the project activity
Source of data:	As specified in the baseline methodology, based on either (a) measurement of efficiency of the PAPP (b) Manufacturer's specification of the efficiency at optimum load (if no retrofit has been undertaken that results in an increased efficiency) (c) the average historical efficiency during the most recent three years prior to the implementation of the project activity
Measurement procedures (if any):	In case of (a): In carrying out the measurements, national or international standards should be used to carry out measurements. All measurements should be carried out at a load factor (or operation mode) that is representative of the situation during the project activity. Where a representative load factor (or operation mode) can not be determined, measurements should be conducted for different load factors (or operation modes) and be weighted by the time these load factors (or operation modes) are typically operated.
Any comment:	~~If the efficiency is measured, all measurements should be conducted at a range of load factor (or operation mode) that is representative of the situation during the project activity. Measurements should be carried out following national or international standards. Where a representative load factor (or operation mode) can not be determined, measurements should be conducted for different load factors (or operation modes) and be weighted by the time these load factors (or operation modes) are typically operated.~~

<table>
<tr><td>Parameter:</td><td>$EF_{FF,BL}$</td></tr>
<tr><td>Data unit:</td><td>tCO_2-/-TJ~~mass or volume unit~~</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of the coal or petroleum fuel used in the PAPP prior 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.</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 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.
For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options b), c) or d) should be used.</td></tr>
<tr><td>Any comment:</td><td>The most plausible baseline scenario may be that several fuel types would be used in the project activity power plant in the absence of the project activity. Where the use of several fuel types is the most plausible baseline scenario, project participants should, for estimating baseline emission factor, as a conservative approach, select the fuel type with the lowest CO_2 emission factor from the fuels used in the power plant during the most recent three years prior to the implementation of the project activity.</td></tr>
</table>

Data / parameter:	$NCV_{FF,BL}$
Data unit:	GJ / mass or volume unit
Description:	Net calorific value of fossil fuel used in the PAPP prior to implementation of the project activity
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 if the carbon fraction of the fuel is not provided (option A).
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.
Any comment:	

Parameter:	$EF_{CO2,upstream,LNG}$
Data unit:	tCO_2/TJ
Description	Emission factor for upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system
Source of data:	Where reliable and accurate data on upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system is available, project participants should use this data to determine an average emission factor. Where such data is not available, project participants may assume a default value of 6 tCO_2/TJ as a rough approximation[7].
Measurement procedures (if any):	-
Any comment:	-

[7] This value has been derived on data published for North American LNG systems. "Barclay, M. and N. Denton, 2005. Selecting offshore LNG process. http://www.fwc.com/publications/tech_papers/files/LNJ091105p34-36.pdf (10th April 2006)".

Parameter:	$EF_{CH4,FF,upstream,i}$ *CH4* and $EF_{CH4,upstream,BL}$
Data unit:	tCH_4/TJ
Description	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of the fuel type *i* (the fossil fuel types used in the PAPP and, where applicable, in the electricity grid) or the used in PAPP (coal or petroleum fuel type used in the PAPP) prior to project implementation of the project activity
Source of data:	Where reliable and accurate national data on fugitive CH4 emissions associated with the production is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH4 emissions by the quantity of fuel produced or supplied respectively[8]. GHG inventory data reported to the UNFCCC as part of national communications can be used where country-specific approaches (and not IPCC Tier 1 default values) have been used to estimate emissions. Where such data is not available, project participants may use the default values provided in the table below.Table 2 in the Leakage section of baseline methodology. In this case, the natural gas emission factor for the location of the project should be used, except in cases where it can be shown that the relevant system element (gas production and/or processing/ transmission/ distribution) is predominantly of recent vintage and built and operated to international standards, in which case the US/Canada values may be used.

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
Coal			
Underground mining	t CH4 / kt coal	13.4	Equations 1 and 4, p. 1.105 and 1.110
Surface mining	t CH4 / kt coal	0.8	Equations 2 and 4, p.1.108 and 1.110
Oil			
Production	t CH4 / PJ	2.5	Tables 1-60 to 1-64, p. 1.129 - 1.131
Transport, refining and storage	t CH4 / PJ	1.6	Tables 1-60 to 1-64, p. 1.129 - 1.131
Total	t CH4 / PJ	4.1	
Natural gas			
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
Processing, transport and distribution	t CH4 / PJ	88	Table 1-60, p. 1.129
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

Note that the emission factor for fugitive upstream emissions for natural gas should include fugitive emissions from production, processing, transport and distribution of natural gas. Note further that in case of coal the emission factor is provided based on a mass unit and needs to be converted in an energy unit, taking into account the net calorific value of the coal.

Measurement procedures (if any):	-
Any comment:	-

[8] GHG inventory data reported to the UNFCCC as part of national communications can be used where country-specific approaches (and not IPCC Tier 1 default values) have been used to estimate emissions.

Parameter:	$EF_{CH4,upstream,grid}$
Data unit:	tCH_4/MWh
Description	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of the fossil fuel types that are used in grid connected power plants in the absence of the project activity
Source of data:	This emission factor should be calculated, consistent with the emission factor used for the grid (CM or BM) and the approaches chosen in the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources", by dividing the upstream emissions associated with the fossil fuel consumption by the quantity of electricity generation considered for the calculation of the CM or BM.
Measurement procedures (if any):	-
Any comment:	-

~~Parameter:~~	~~$EF_{NG,upstream,CH4}$~~
~~Data unit:~~	~~tCH_4/TJ~~
~~Description~~	~~Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas.~~
~~Source of data:~~	~~Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH_4 emissions by the quantity of fuel produced or supplied respectively[9]. Where such data is not available, project participants may use the default values provided in Table 2 given in Leakage section of the baseline methodology.~~
~~Measurement procedures (if any):~~	~~See baseline methodology.~~
~~Any comment:~~	~~-~~

Parameter:	CAP_{max}
Data unit:	MW
Description	Maximum power generation capacity of the PAPP prior to the implementation of the project activity.
Source of data:	Measurement
Measurement procedures (if any):	Measurements as per the "procedure for estimating the installed capacity of the power plant" in the baseline methodology
Any comment:	-

[9] GHG inventory data reported to the UNFCCC as part of national communications can be used where country-specific approaches (and not IPCC Tier 1 default values) have been used to estimate emissions.

Parameter:	T_{max}
Data unit:	hours
Description	Maximum amount of time in which the project activity power plant could have operated at full load prior to the implementation of the project activity
Source of data:	Subtract from 8760 hours the average hours per year in which the plant can not operate due to maintenance or repair. Use historical records for such maintenance and repair intervals.
Measurement procedures (if any):	-
Any comment:	-

Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description	Global warming potential of methane valid for the relevant commitment period.
Source of data:	IPCC
Measurement procedures (if any):	Default value for the first commitment period = 21 tCO_2e/tCH_4
Any comment:	-

III. MONITORING METHODOLOGY

Monitoring procedures

The monitoring procedures are explained below in the respective tables of each parameter.

In addition, the provisions in the monitoring methodology of the latest approved version of the following tools apply:

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

Data and parameters monitored

Data / Parameter:	Installed capacity ~~and electricity generation~~
Data unit:	MW ~~and MWh, respectively~~
Description:	Installed capacity ~~and electricity generation~~ of the project power plant.
Source of data:	Project site
Measurement procedures (if any):	The installed capacity ~~and actual generation~~ of the power plant before and after the fuel switch activity needs to be tested using internationally approved standard methods available with the help of reputed players or manufacturers in the market. The test report for the same is needed to be submitted to DOE during the validation/verification to check the same. Changes in capacity ~~and generation~~ must remain within ±5% of the capacity ~~/generation~~ before the implementation of the project activity, as per the applicability conditions.
Monitoring frequency:	Annually ~~Monthly~~
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$EC_{PJ,aux,y}$ ~~$EL_{aux,grid,y}$~~
Data unit:	MWh
Description:	~~Electricity used in the project power plant to serve auxiliary and back-loads that is obtained from the grid, if any.~~Auxiliary electricity consumption by the project activity in year *y*
Source of data:	On-site measurements~~Electricity meters at the project site.~~
Measurement procedures (if any):	Use electricity meters~~Read electricity meters and record information.~~
Monitoring frequency:	Continuously, aggregated at least annually ~~Monthly~~
QA/QC procedures:	Cross check measurement results with invoices for purchased electricity if relevant. ~~As per electricity meter databook.~~
Any comment:	-

Data / Parameter:	**~~EL~~$G_{PJ,by}$** ~~$EL_{PR,y}$~~
Data unit:	MWh
Description:	Quantity of electricity supplied by the project activity power plant to the electricity grid or captive consumer(s) in year *y*~~Electricity supplied to the captive consumer/electricity grid in year *y* of the crediting period.~~
Source of data:	On-site measurements~~Electricity meters at the project site.~~
Measurement procedures (if any):	Use electricity meters~~Read electricity meters and record information.~~
Monitoring frequency:	Continuously, aggregated at least annually~~Monthly~~
QA/QC procedures:	Cross check measurement results with invoices for purchased electricity if relevant. ~~As per electricity meter databook.~~
Any comment:	-

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO_2/MWh
Description:	Emission factor of the electricity grid to which the PAPP is connected.
Source of data:	Use the lower emission factor between the combined margin emission factor ($EF_{grid,CM,y}$) and the build margin emission factor ($EF_{grid,BM,y}$), calculated and monitored according to the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
Measurement procedures (if any):	As per the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
Monitoring frequency:	As per the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
QA/QC procedures:	As per the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
Any comment:	As per the latest approved version of "ACM0002 - Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

Data / Parameter:	$PE_{FC,j,y}$
Data unit:	tCO_2
Description:	Project emissions from combustion of natural gas and auxiliary fossil fuel use in the project activity power plant in year *y* where j refers to the combustion of fossil fuels in the project activity power plant and, if applicable, any other fossil fuel consumption at the project site that is attributable to the project activity
Source of data:	As per the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Measurement procedures (if any):	As per the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Monitoring frequency:	As per the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
QA/QC procedures:	As per the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Any comment:	As per the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

Data / Parameter:	$FC_{PAPP,i,y}$ and $FC_{PAPP,NG,y}$
Data unit:	mass or volume unit
Description:	Quantity of fossil fuel type *i* combusted in the project activity power plant in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use mass or volume meters
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered fuel consumption quantities should be crosschecked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Any comment:	-

~~Data / parameter:~~	~~$FF_{aux,i,y}$~~
~~Data unit:~~	~~mass or volume units~~
~~Description:~~	~~Total amount of fossil fuel *i* used in the project power plant to serve auxiliary and back-up loads in year *y* of the crediting period.~~
~~Source of data:~~	~~Data logs at the project site.~~
~~Measurement procedures (if any):~~	~~-~~
~~Monitoring frequency:~~	~~Monthly~~
~~QA/QC procedures:~~	~~-~~
~~Any comment:~~	~~-~~

~~**Data / parameter:**~~	~~**$EF_{elec,y}$**~~
~~Data unit:~~	~~tCO_2/MWh~~
~~Description:~~	~~Emission factor for the grid in year *y*~~
~~Source of data:~~	~~Choose one of the following options:~~ ~~□ Calculate the combined margin emission factor, using the procedures in the latest approved version of the "Consolidated baseline methodology for grid~~

	connected electricity generation from renewable sources" (ACM0002); □ Use a conservative default value of 1.3 tCO_2/MWh.
Measurement procedures (if any):	-
Monitoring frequency:	Follow procedures as described in ACM0002
QA/QC procedures:	Follow procedures as described in ACM0002
Any comment:	

<table>
<tr><td>Parameter:</td><td>$EF_{NG,y}$</td></tr>
<tr><td>Data unit:</td><td>tC / mass or volume unit</td></tr>
<tr><td>Description:</td><td>CO_2 emission factor of the Natural gas used in the PAPP 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><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>e)Values provided by the fuel supplier in invoices</td><td>This is the preferred source.</td></tr><tr><td>f)Measurements by the project participants</td><td>If a) is not available</td></tr><tr><td>g)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>h)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>Monitoring frequency:</td><td>For a) and b): The CO_2 emission factor 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</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.
For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options b), c) or d) should be used.</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Parameter:	$EF_{i,y}$
Data unit:	tC / mass or volume unit
Description:	CO_2 emission factor of the fossil fuel, other than natural gas, used in the PAPP to serve auxiliary and back-up loads in year y
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	Conditions for using the data source
i)Values provided by the fuel supplier in invoices	This is the preferred source.
j)Measurements by the project participants	If a) is not available
k)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).
l)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

Monitoring frequency:	For a) and b): The CO_2 emission factor 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
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards. For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options b), c) or d) should be used.
Any comment:	

Data / parameter:	$NCV_{i,y}$, $NCV_{i,x}$ **and** $NCV_{NG,y}$
Data unit:	TGJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description:	Weighted average net calorific value of fossil fuel type *i* used in year *x* or *y*natural gas in year *y*, referred to in the same basis (pressure and temperature) as $FC_{PAPP,NG,y}$
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 if the carbon fraction of the fuel is not provided (option A).
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.	
Monitoring frequency:	For a) and b): 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	
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:	Note that for the NCV the same basis (pressure and temperature) should be used as for the fuel consumption~~Applicable where option B is used.~~	

<table>
<tr><td>Data / parameter:</td><td>$NCV_{i,y}$</td></tr>
<tr><td>Data unit:</td><td>TJ per mass or volume unit</td></tr>
<tr><td>Description:</td><td>Weighted average net calorific value of fossil fuel type i</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) 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>For a) and b): 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</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>Applicable where option B is used.</td></tr>
</table>

Data / parameter:	$NCV_{i,x}$
Data unit:	TJ per mass or volume unit
Description:	Net calorific value of the fossil fuel *i* used in the PAPP before the implementation of the project activity. If more than one fuel was used, choose the fuel with the lowest $EF_{upstream,CH4}$.
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 if the carbon fraction of the fuel is not provided (option A).
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.
Monitoring frequency:	For a) and b): 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
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:	Applicable where option B is used.

~~Data / parameter:~~	~~NG_y~~
~~Data unit:~~	~~mass or volume units~~
~~Description:~~	~~Total amount of natural gas used in the project power plant in year y of the crediting period.~~
~~Source of data:~~	~~Data logs at the project site.~~
~~Measurement procedures (if any):~~	~~-~~
~~Monitoring frequency:~~	~~Monthly~~

~~QA/QC procedures:~~	-	
~~Any comment:~~	-	

References and any other information

Not applicable.