Draft baseline and monitoring methodology AM0XXX

"Greenfield cogeneration facility supplying electricity and steam to a Greenfield Industrial Consumer and exporting excess electricity to a grid and/or project customer(s)"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

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

- AM0029 Version 3.0 "Baseline methodology for grid connected electricity generating plants using natural gas";
- AM0084 Version 1.0 "Installation of cogeneration system supplying electricity and chilled water to new and existing consumers";
- NM0352 "New cogeneration facilities supplying electricity and steam to a Greenfield Industrial Consumer with Excess Power Generated exported to a Grid and/or other Dedicated Consumer(s)" prepared by Dr. Felix Dayo (Triple E Systems Inc) and Dr. Deborah Cornland (Cornland International).

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

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool to calculate the emission factor for an electricity system";
- "Tool to determine the remaining lifetime of equipment";
- "Assessment of the validity of the current/original baseline and update of the baseline at the renewal of the crediting period".

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

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

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

"The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category".

Definitions

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

Greenfield Industrial Consumer. A Greenfield industrial facility which is collocated with the Greenfield project facility and which consumes all the heat/steam and all/part of the electricity produced by the project facility.

Project Customer(s). One or more existing industrial entity(ies) outside the project facility site, receiving electricity from the project facility.

Cogeneration. Simultaneous production of electricity and heat using fossil fuel.

Applicability

This methodology applies to project activities that involve the installation of a Greenfield cogeneration facility (hereafter referred to as project facility) at the site of a Greenfield industrial consumer. The project facility supplies steam and electricity directly to the Greenfield industrial consumer for captive use and exports excess electricity to project customers and/or a grid.[1] The project facility is designed primarily to meet the heat/steam demand of the Greenfield industrial consumer.

The methodology is applicable under the following conditions:

- The methodology is not applicable to project activities involving the use of solid fuels. The fuel used at the project facility must be gaseous or liquid. If multiple fuels (excluding fuels used for start-up[2] only) are expected to be used by the project facility, each type of the multiple fuels must be identified ex ante in the PDD;
- The heat-to-power ratio of the project cogeneration facility shall be higher than 1.
- If the baseline scenario is to generate heat/steam by a reference boiler (i.e. H2) as identified through the procedures contained in Annex I, the methodology is applicable only: (1) if the relevant information required in Annex I to identify the reference boiler is available and (2) if the fuel of the reference boiler, as indentified through the procedures in Annex I, is the same as the project fuel or one of the multiple fuels used by the project facility; and
- If the baseline scenario is to generate electricity entirely or partly by a reference captive power plant (i.e. P2 or P3) as identified through the procedures in Annex I, The methodology is applicable only (1) if the relevant information required in Annex I to identify the reference captive power plant is available and (2) if the fuel of the reference captive power plant, as indentified through the procedures in Annex I, is the same as the project fuel or one of the multiple fuels used by the project facility;
- The Greenfield industrial consumer shall satisfy all the following conditions:
    - The owner of the project facility is also the owner of the Greenfield industrial consumer;
    - The Greenfield industrial consumer will consume all the heat/steam and all/part of the electricity produced by the project facility;
    - The project facility must provide all of the electricity and heat/steam demand of the Greenfield industrial consumer;
- All of the following conditions apply to each of the project customers. If any of the condition is not met for project customer *i*, no emission reduction can be claimed for the power supplied to project customer *i*.
    - The captive power plant(s) of project customer *i* does not involve cogeneration;
    - Project customer *i* does not receive/purchase electricity from sources other than its own captive plants, the project facility or the grid;

[1] Grid is defined as per the "Tool to calculate the emission factor for an electricity system".

[2] Start-up fuels shall not comprise more than 3% of total fuel used annually, on an energy basis;

- The existing captive power plant(s) of project customer *i* shall have records on the fuel consumption and electricity production for one year prior to the implementation of the project activity;
- All potential project customers shall be identified ex ante in the PDD. If power generated by the project facility is supplied to any customer not identified in the registered PDD, then the latest version of the "Procedures for notifying and requesting approval of changes from the project activity as described in the registered PDD" shall be followed.

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

II. BASELINE METHODOLOGY PROCEDURE

Identification of the baseline scenario and demonstration of additionality

Project participants shall determine the most plausible baseline scenario through the application of the steps prescribed by the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality." The following requirements shall be satisfied in application of the tool.

Step 1: Identification of alternative scenarios

The following alternatives shall be considered:

- Alternatives for meeting the electricity demand of the Greenfield industrial consumer in the absence of the project activity;
- Alternatives for meeting the heat/steam demand of the Greenfield industrial consumer in the absence of the project activity;
- Alternatives for meeting the electricity demand of each of the project customer in the absence of the project activity.

The alternative scenarios for electricity supplied to the Greenfield industrial consumer shall include *inter alia*:

P1: The proposed project activity not undertaken as a CDM project activity;

P2: Electricity is supplied partly from a grid and partly from an off-grid captive power plant applying the fuel and technology identified for the reference captive power plant through the procedures in Annex I;

P3: Electricity is supplied from an off-grid captive power plant applying the fuel and technology identified for the reference captive power plant through the procedures in Annex I;

P4: Electricity is imported from a grid.

P5: Electricity is supplied from a cogeneration plant fired with a different fossil fuel than the project activity; and

P6: Electricity is supplied from a biomass fired cogeneration plant.

If multiple fuels are used by the project facility, the alternatives to be considered shall also include variations of P2 and P3 (P2i and P3i corresponding to fuel *i*), which would use each of the multiple fuels used by the project facility instead of the fuel identified for the reference captive power plant through the procedures in Annex I.

The alternative scenarios for heat/steam supplied to the Greenfield industrial consumer shall include *inter alia*:

H1: The proposed project activity not undertaken as a CDM project activity;

H2: Heat/steam is supplied by a stand alone boiler applying the fuel and technology identified for the reference boiler through the procedures in Annex I;

H3: Heat/steam is supplied from a cogeneration plant fired with a different fossil fuel than the project activity;

H5: Electricity is supplied from a cogeneration plant fired with a different fossil fuel than the project activity; and

H4: Heat/steam is supplied by a biomass fired cogeneration plant.

If multiple fuels are used by the project facility, the alternatives to be considered shall also include variations of H2 (H2i corresponding to fuel *i*), which would use each of the multiple fuels used by the project facility instead of the fuel identified for the reference boiler through the procedures in Annex I.

The alternative scenarios for electricity supplied to project customer *i* shall include *inter alia*:

B1: The project customer imports the electricity from the grid;

B2: The electricity is supplied from the existing off-grid captive fossil fuel fired power plant(s);

B3: The electricity is supplied partly from the grid and partly from the existing off-grid captive fossil fuel fired power plant(s);

B4: The electricity is supplied from a new off-grid captive fossil fired power plant (with a capacity corresponding to the amount of electricity to be imported from the project activity);

B5: The electricity is supplied from a new on-site renewable energy power plant;

B6: The electricity is supplied from a new on-site fossil-fuel fired cogeneration plant;

B7: The electricity is supplied from a new on-site biomass fired cogeneration plant; and

B8: The proposed project activity not undertaken as a CDM project activity;

Step 2: Investment analysis

A comparative investment analysis is required for the identification of the baseline scenario and the assessment of additionality.

An integrated investment analysis combining the baseline scenarios for the Greenfield industrial consumer and all the project customers shall be performed to determine the baseline scenario. In Step 1, although the alternatives may first be identified separately for the various energy supplies, i.e. (1) the electricity supplied to the Greenfield industrial consumer; (2) the heat supplied to the Greenfield industrial consumer; and (3) the electricity supplied to the project customers, the economic comparison of the baseline scenario alternatives should be performed on the basis of the total cost to generate the total amount of electricity and heat to be provided by the project facility and should cover all the possible and realistic combinations of the various baseline scenario alternatives for the different energy consumers.

The investment analysis shall explicitly state the following parameters:

- Investment requirements (including break-up into major equipment costs, required construction work, and installation);
- Efficiency of equipment, taking into account any differences between fuels;

- Operating costs for each fuel (especially, handling/treatment costs);
- Other operation and maintenance cost;
- Any income generated from the sale of electricity to the grid, should be accounted for in the investment analysis.

The sensitivity analysis shall include different combination in export patterns, i.e. the export to one project customer versus the export to another project customer.

This methodology is only applicable if the application of the procedure to identify the baseline scenario results in the following alternatives as the most plausible baseline scenario:

- The baseline scenario for electricity supplied to the Greenfield industrial consumer is P2 (or P2i), P3 (or P3i) or P4;
- The baseline scenario for heat/steam supplied to the Greenfield industrial consumer is H2 (or H2i); and
- The baseline scenario electricity supplied to each of the project customers is B1, B2 or B3.

If multiple fuels are used in the project facility:

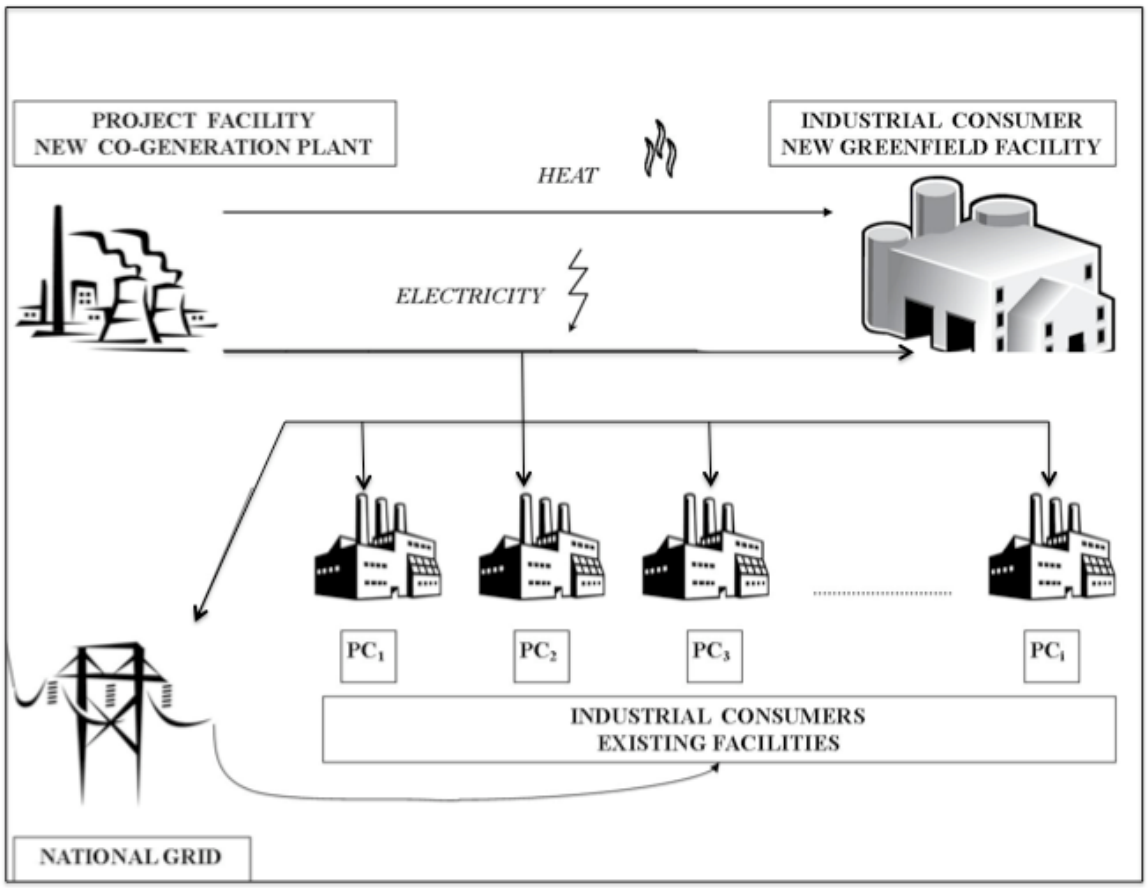
- If P2 or any of the P2i scenarios is identified as the baseline scenario for electricity generation, P2 and all P2i scenarios shall be financially more attractive than the proposed project activity not undertaken as a CDM project activity;
- If P3 or any of the P3i scenarios is identified as the baseline scenario for electricity generation, P3 and all P3i scenarios shall be financially more attractive than the proposed project activity not undertaken as a CDM project activity; and
- H2 and all H2i scenarios shall be financially more attractive than the proposed project activity not undertaken as a CDM project activity.

Project boundary

The **spatial extent** of the project boundary encompasses the site of the project facility, the sites of all project customers, and, if the project facility exports power to a grid, all power plants connected physically to the grid.

The project boundary is presented in Figure 1.

Figure 1: The Project Boundary



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	Combustion of fossil fuels to produce heat/steam at the project facility	CO_2	Yes	Main emission source in the combustion of fossil fuels
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Combustion of fossil fuels to produce electricity at the project facility	CO_2	Yes	Main emission source in the combustion of fossil fuels
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Combustion of fossil fuels to produce electricity for Project Customers	CO_2	Yes	Main emission source in the combustion of fossil fuels
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Combustion of fossil fuels to produce electricity for the grid	CO_2	Yes	Main emission source in the combustion of fossil fuels
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project activity	Combustion of fossil fuels to produce heat/steam and electricity at the project facility	CO_2	Yes	Main emission source in the combustion of fossil fuels
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

Project emissions

Project emissions include emissions from fossil fuel consumption at the project site for the generation of electric power and heat and for auxiliary loads related to the generation of electric power and heat. Even if emission reductions are not claimed for some project customer(s), all the fossil fuel consumption for the electricity and heat generation at the project facility should be included in the project emission calculations.

Project emissions PE_y are calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". The combustion process *j* as referred to in the tool should include the following:

- On-site fossil fuel consumption for the generation of electric power and heat. This includes all fossil fuels used at the project site in heat generators (e.g. boilers) for the generation of electric power and heat; and
- On-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat. This includes fossil fuels required for the operation of auxiliary equipment related to the power and heat plants (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.) which are not accounted in the first bullet, and fossil fuels

required for the operation of equipment related to the preparation, storage and transportation of fuels (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.).

Baseline emissions

Baseline emissions include emissions from consumption of fossil fuels for the electricity and heat/steam that would be generated at the site of the Greenfield industrial consumer, from consumption of fossil fuels at the sites of the project consumers for the electricity imported from the project activity, and from consumption of fossil fuels to supply the electricity to the grid. Baseline emissions are calculated by the following equations:

$$BE_y = BE_{GIC,p,y} + BE_{GIC,ST,y} + \sum_i BE_{PC,i,y} + BE_{grid,y} \quad \textbf{(1)}$$

Where:

BE_y = Baseline emissions in year *y* (t CO_2/yr)
$BE_{GIC,p,y}$ = Baseline emissions from the production of electricity supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)
$BE_{GIC,ST,y}$ = Baseline emissions from the production of heat/steam supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)
$BE_{PC,i,y}$ = Baseline emissions from the production of electricity supplied to project customer *i* in year *y* (t CO_2/yr)
$BE_{grid,y}$ = Baseline emissions from the production of electricity supplied to the grid in year *y* (t CO_2/yr)

1. Baseline emissions for electricity supplied to the Greenfield industrial consumer, $BE_{GIC,p,y}$

In the absence of the project activity, the electricity demand of the Greenfield industrial consumer can be met by a Greenfield captive power plant, or by the grid, or a combination of both. For each of these three scenarios, the baseline emissions for the generation of the electricity provided by the project facility to the Greenfield industrial consumer can be calculated using one of the three approaches outlined below.

a. Electricity supplied by a Greenfield captive power plant

In the absence of the project activity, the electricity demand of the Greenfield industrial consumer can be met entirely by a Greenfield fossil fuel fired captive power plant implemented at the project site. The baseline emissions for the generation of the electricity provided to the Greenfield industrial consumer are calculated with the equation below.

$$BE_{GIC,p,y} = EG_{GIC,y} \times 0.0036(TJ/MWh) \times \frac{\min(EF_{CO2,RPF}, EF_{CO2,PJ,y})}{\eta_{RP}} \quad \textbf{(2)}$$

Where:

$BE_{GIC,p,y}$ = Baseline emissions from the production of electricity supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)
$EG_{GIC,y}$ = Quantity of electricity generated by the project facility that is supplied to the Greenfield industrial consumer in year *y* (MWh/yr)
$EF_{CO2,RPF}$ = CO_2 emission factor of the fuel used by the reference captive power plant (t CO2/TJ)
$EF_{CO2,PJ,y}$ = CO_2 emission factor of the fuel(s) used by the project facility in year *y* (t CO2/TJ)
η_{RP} = Design energy efficiency of the reference captive power plant (fraction)

The emission factor of the fuel(s) used by the project facility in year *y* is calculated according to the equation below.

$$EF_{CO2,PJ,y} = \frac{\sum_i (EF_{CO2,i,y} \times NCV_{i,y} \times FC_{i,y})}{\sum_i (NCV_{i,y} \times FC_{i,y})} \quad \textbf{(3)}$$

Where:

$EF_{CO2,PJ,y}$ = CO_2 emission factor of the fuel(s) used by the project facility in year *y* (t CO2/TJ)

$EF_{CO2,i,y}$ = Weighted average CO_2 emission factor of fuel type *i* in year *y* (t CO2/GJ), monitored as per "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

$NCV_{i,y}$ = Weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit), monitored as per "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

$FC_{i,y}$ = Quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr), monitored as per "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

b. Electricity supplied by the grid

In the absence of the project activity, the electricity demand of the Greenfield industrial consumer may be met by the grid. The baseline emissions for the generation of the electricity provided to the Greenfield industrial consumer are calculated with the equation below.

$$BE_{GIC,p,y} = EG_{GIC,y} \times EF_{grid,y} \quad \textbf{(4)}$$

Where:

$BE_{GIC,p,y}$ = Baseline emissions from the production of electricity supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)

$EG_{GIC,y}$ = Quantity of electricity generated by the project facility that is supplied to the Greenfield industrial consumer in year *y* (MWh/yr)

$EF_{grid,,y}$ = Emission factor for the grid in year *y* (t CO_2/MWh)

The emission factor for the baseline electricity supply corresponds to the grid emission factor. The emission factor for grid electricity (t CO_2/MWh) is calculated according to the procedure to determine the combined margin (CM) in the latest version of the "Tool to calculate the emission factor for an electricity system". $EF_{grid,y}$ corresponds to the parameter $EF_{grid,CM,y}$, combined margin CO_2 emission factor for the project electricity system in year *y*, in the tool referred to above.

c. Electricity supplied partly by a Greenfield captive power plant and partly by the grid

In the absence of the project activity, the electricity demand of the Greenfield industrial consumer can be met partly by the grid and partly by a Greenfield captive fossil fuel fired power plant installed at the project site. The baseline emissions for the generation of the electricity provided to the Greenfield industrial consumer are calculated with the equation below.

$$BE_{GIC,p,y} = EG_{GIC,y} \times Min\{EF_{grid,y}, EF_{RP}\} \quad \textbf{(5)}$$

Where:

$BE_{GIC,p,y}$ = Baseline emissions from the production of electricity supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)

$EG_{GIC,y}$ = Quantity of electricity generated by the project facility that is supplied to the Greenfield industrial consumer in year *y* (MWh/yr)

$EF_{grid,,y}$ = Emission factor for the grid in year *y* (t CO_2/MWh)

EF_{RP} = Emission factor of the reference captive power plant, which would have supplied electricity to the Greenfield industrial consumer in the absence of the project activity during the year *y* (t CO_2/MWh)

The emission factor for the baseline electricity supply is the minimum between the emission factor of the reference captive power plant EF_{RP} and the grid emission factor $EF_{grid,y}$, to be calculated by the procedures outlined for the first two baseline scenarios for the electricity supplied to the Greenfield industrial consumer.

2. Baseline Emissions for heat/steam supplied to the Greenfield industrial consumer, $BE_{GIC,ST,y}$

In the absence of the project activity, the heat demand of the Greenfield industrial consumer is met through a Greenfield captive fossil fuel fired boiler installed at the project site or at the consumer site. The steam generated by the project facility is only supplied to the Greenfield industrial consumer and must meet its total heat demand. The maximum heat generation capacity of the project facility in any year *y* of the crediting period is limited by the maximum heat demand of the Greenfield industrial consumer in this respective year *y*. The baseline emissions from the production of heat that is generated in the reference boiler for the supply of heat to the Greenfield industrial consumer in the absence of the project activity can be calculated as follows:

$$BE_{GIC,ST,y} = HG_{GIC,y} \times EF_{RB} \quad \textbf{(6)}$$

Where:

$BE_{GIC,ST,y}$ = Baseline emissions from the production of heat/steam supplied to the Greenfield industrial consumer in year *y* (t CO_2/yr)

$HG_{GIC,y}$ = Quantity of steam/heat generated by the project facility that is supplied to the Greenfield industrial consumer in year *y* (TJ/yr)

EF_{RB} = Emission factor of the reference boiler, which would have supplied steam/heat to the Greenfield industrial consumer in the absence of the project activity in year *y* (t CO_2/TJ)

The emission factor for the baseline steam generation is based on the design parameters of the reference boiler identified through the procedures in Annex I. The emission factor of the reference boiler EF_{RB} is calculated as follows:

$$EF_{RB} = \frac{\min(EF_{CO2,RBF}, EF_{CO2,PJ,y})}{\eta_{RB}} \quad \textbf{(7)}$$

Where:

EF_{RB} = Emission factor of the reference boiler, which would have supplied steam to the Greenfield industrial consumer in the absence of the project activity in year *y* (tCO_2/TJ)

$EF_{CO2,RBF}$ = CO_2 emission factor of the fuel used by the reference boiler (t CO_2/TJ)

$EF_{CO2,PJ,y}$ = CO_2 emission factor of the fuel(s) used by the project facility in year *y* (t CO2/TJ)

η_{RB} = Design energy efficiency of the reference boiler (fraction)

3. Baseline Emissions for electricity supplied to project customer *i*, $BE_{PC,i,y}$

In the absence of the project activity, the electricity supplied by the project facility to the project customers can be met by an existing captive power plant(s) at the site of the project customer, or by the grid, or a combination of both. For each of these three scenarios, the baseline emissions for the generation of the electricity provided by the project facility to project customer *i* can be calculated using one of the three approaches outlined below.

The baseline emissions are conservatively calculated using approach C below, assuming that the electricity would be supplied by a combination of both the grid and the existing captive power plant(s), for the following situations:

- If project customer *i* is grid-connected and has existing captive power plant(s),
- After the end of the lifetime of at least one of the existing captive power plant(s), determined as per the "Tool to determine the remaining lifetime of equipment".

a. Electricity supplied by an existing captive power plant(s)

In the absence of the project activity, the electricity demand of project customer *i* can be met entirely by an existing fossil fuel fired captive power plant(s) installed at the customer site. The baseline emissions for the generation of the electricity provided to project customer *i* are calculated with the equation below. If there are multiple on-site captive power plants that could supply to project customer *i*, the emission factor of the least carbon intensive power generation unit will be conservatively applied in the baseline emission calculations.

$$BE_{PC,i,y} = \min\left\{EG_{PC,i,y}, \sum_{j} EG_{cap,i,j}\right\} \times \min\left\{EF_{i,j}\right\} \quad \textbf{(8)}$$

Where:

$BE_{PC,i,y}$ = Baseline emissions from the production of electricity supplied to project customer *i* in year *y* (t CO_2/yr)

$EG_{PC,i,y}$ = Quantity of electricity generated by the project facility that is supplied to project customer *i* in year *y* (MWh/yr)

$EG_{cap,i,j}$ = Historical maximum electricity generation of existing fossil fuel fired captive power plant *j* at the site of project customer *i* (MWh/yr)

$EF_{i,j}$ = Emission factor of existing fossil fuel fired captive power plant *j* at the site of project customer *i* (t CO_2/MWh)

The emission factor for the baseline electricity generation is based on the fuel consumption and the electricity generation information of the latest year available. The emission factor of existing captive fossil fuel fired power plant *j* at the site of project customer *i*, $EF_{i,j}$, is calculated according to the equation below.

$$EF_{i,j} = \frac{\sum_{k}(FC_{i,j,k} \times NCV_{i,j,k} \times EF_{CO2,k})}{EG_{i,j}} \quad \textbf{(9)}$$

Where:

$EF_{i,j}$ = Emission factor of existing fossil fuel fired captive power plant *j* at the site of project customer *i* (t CO_2/MWh)

$FC_{i,j,k}$ = Quantity of fossil fuel type *k* fired in captive power plant *j* in the year prior to the implementation of the project activity (mass or volume unit)

$NCV_{i,j,k}$ = Net calorific value of fossil fuel type *k* fired in captive power plant *j* (GJ/mass or volume unit)
$EF_{CO2,k}$ = CO_2 emission factor of fossil fuel type *k* (t CO_2/GJ)
$EG_{i,j}$ = Quantity of electricity generated in captive power plant *j* at the site of project customer *i* in the year prior to the implementation of the project activity (MWh)

b. Electricity supplied by the grid

In the absence of the project activity, the electricity demand of project customer *i* may be met by the grid to which the project customer would be connected. The baseline emissions for the generation of the electricity provided to project customer *i* are calculated with the equation below.

$$BE_{PC,i,y} = EG_{PC,i,y} \times EF_{grid,i,y} \quad \textbf{(10)}$$

Where:
$BE_{PC,i,y}$ = Baseline emissions from the production of electricity supplied to project customer *i* in year *y* (t CO_2/yr)
$EG_{PC,i,y}$ = Quantity of electricity generated by the project facility that is supplied to project customer *i* in year *y* (MWh/yr)
$EF_{grid,i,,y}$ = Emission factor for the grid to which project customer *i* would be connected in the absence of the project activity in year *y* (t CO_2/MWh)

The emission factor for the baseline electricity supply correspond to the grid emission factor. The emission factor for grid electricity (t CO_2/MWh) is calculated *ex ante* according to the procedure to determine the combined margin (CM) in the latest version of the "Tool to calculate the emission factor for an electricity system". $EF_{grid,i,y}$ corresponds to the parameter $EF_{grid,CM,y}$ in the tool referred to above.

c. Electricity supplied partly by an existing captive power plant and partly by the grid

In the absence of the project activity, the electricity demand of project customer *i* can be met partly by the grid and partly by an existing captive fossil fuel fired power plant(s) installed at the project site. The baseline emissions for generation of the electricity provided to project customer *i* are calculated with the equation below.

$$BE_{PC,i,y} = EG_{PC,i,y} \times Min\{EF_{i,j}, EF_{grid,i,y}\} \quad \textbf{(11)}$$

Where:
$BE_{PC,i,y}$ = Baseline emissions from the production of electricity supplied to project customer *i* in year *y* (t CO_2/yr)
$EG_{PC,i,y}$ = Quantity of electricity generated by the project facility that is supplied to project customer *i* in year *y* (MWh/yr)
$EF_{grid,i,y}$ = Emission factor for the grid to which project customer *i* would be connected in the absence of the project activity in year *y* (t CO_2/MWh)
$EF_{i,j}$ = Emission factor of existing fossil fuel fired captive power plant *j* at the site of project customer *i* (tCO_2/MWh)

The emission factor for the baseline electricity supply is the minimum of the emission factor(s) of the existing captive fossil fuel fired power plant(s) at the site of project customer *i* and the grid emission factor $EF_{grid,i,y}$, to be calculated by the procedures outlined for the first two baseline scenarios for generation of the electricity supplied to project customer *i*.

4. Baseline emissions for electricity supplied to the grid, $BE_{Grid,y}$

In the absence of the project activity, the electricity supplied to the grid by the project facility is met through additional electricity generated by the other power plants connected to the grid.

$$BE_{Grid,y} = EG_{Grid,y} \times EF_{Grid,y} \quad \textbf{(12)}$$

Where:

$BE_{Grid,y}$ = Baseline emissions from the production of electricity supplied to the grid in year *y* (t CO_2/yr)

$EG_{Grid,y}$ = Quantity of electricity generated by the project facility that is supplied to the grid in year *y* (MWh/yr)

$EF_{Grid,,y}$ = Emission factor for the grid in year *y* (t CO_2/MWh)

The emission factor for grid electricity (t CO_2/MWh) is calculated *ex ante* according to the procedure to determine the combined margin (CM) in the latest version of the "Tool to calculate the emission factor for an electricity system". $EF_{grid,y}$ corresponds to the parameter $EF_{grid,CM,y}$ in the tool referred to above.

Leakage

Leakage emissions are to be included (1) if natural gas is used in the project facility and (2) if the baseline emissions for the electricity supplied to the Greenfield industrial consumer are calculated using approach B or approach C, i.e. the electricity of the Greenfield industrial consumer is not solely supplied by a Greenfield captive power plant in the absence of the project activity.

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. In this methodology, the following leakage emission sources shall be considered:[3]

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant, and in the baseline captive power plant and boiler for the Greenfield industrial consumer;
- In the case that LNG is used in the project plant, CO_2 emissions are to be accounted for due to fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, the leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y} \quad \textbf{(13)}$$

Where:

LE_y = Leakage emissions in the year *y* (t CO_2e /yr)

$LE_{CH4,y}$ = Leakage emissions due to fugitive upstream CH_4 emissions in year *y* (t CO_2e/yr)

$LE_{LNG,CO2,y}$ = 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 in year *y* (t CO_2e/yr)

[3] The Board 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.

For the calculation of the leakage emissions, the natural gas used to produce heat/steam of the Greenfield industrial consumer shall be subtracted from the total amount of natural gas consumption of the project facility, as in the absence of the project activity, the heat/steam would be produced with the same fossil fuel(s) in a stand-alone boiler.

$$FC_{NG,LE,y} = FC_{NG,y} - \frac{HG_{GIC,y} \times 1000}{\eta_{RB}} \times \frac{FC_{NG,y}}{\sum_i (FC_{i,y} \cdot NCV_{i,y})} \quad \textbf{(14)}$$

Where:

$FC_{NG,LE,y}$	=	Quantity of natural gas consumption to be included in the leakage emission calculations in year *y* (m³/yr)
$FC_{NG,y}$	=	Quantity of natural gas combusted in the project plant in year *y* (m³/yr)
$HG_{GIC,y}$	=	Quantity of steam/heat generated by the project facility that is supplied to the Greenfield industrial consumer in year *y* (TJ/yr)
η_{RB}	=	Design energy efficiency of the reference boiler (fraction)
$NCV_{i,y}$	=	Weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit), monitored as per "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
$FC_{i,y}$	=	Quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr), monitored as per "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

Fugitive methane emissions ($LE_{CH4,y}$)

Fugitive CH_4 emissions should be estimated as follows:

$$LE_{CH4,y} = FC_{NG,LE,y} \times NCV_{NG,y} \times EF_{NG,upstream,CH4} \times GWP_{CH4} \quad \textbf{(15)}$$

Where:

$LE_{CH4,y}$	=	Leakage emissions due to fugitive upstream CH_4 emissions in year *y* (tCO_2e/yr)
	=	
$FC_{NG,LE,y}$	=	Quantity of natural gas consumption to be included in the leakage emission calculations in year *y* (m³/yr)
$NCV_{NG,y}$	=	Average net calorific value of the natural gas combusted during the year *y* (GJ/m³)
$EF_{NG,upstream,CH4}$	=	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system (t CH_4/GJ)
GWP_{CH4}	=	Global warming potential of methane valid for the relevant commitment period (t CO_2e/tCH_4)

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.[4] Where such data is not available, project participants should use the default values provided in Table 2 below.

[4] 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.

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. Where default values from this table are used, the natural gas emission factors for the location of the project activity should be used. The US/Canada values may be used 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.

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 ($LE_{LNG,CO2,y}$)

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 as follows:

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

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 in year *y* (t CO_2e/yr)
$FC_{NG,LE,y}$	=	Quantity of natural gas consumption to be included in the leakage emission calculations in year *y* (m^3/yr)
$NCV_{NG,y}$	=	Average net calorific value of the natural gas combusted in year *y* (GJ/m^3)
$EF_{CO2,upstream,LNG}$	=	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 (t CO_2e/GJ)

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_{2e}/TJ as a rough approximation[5] (this value has to be converted to the appropriate units in order to be correctly used in the equations provided in the methodology).

Emission reductions

Emission reductions are calculated as follows:

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

Where:

ER_y	=	Emission reductions in year *y* (t CO_2/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
PE_y	=	Project emissions in year *y* (t CO_2/yr)
LE_y	=	Leakage emissions in year *y* (t CO_2/yr)

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

The required changes should be assessed using the tool for "Assessment of the validity of the current/original baseline and update of the baseline at the renewal of the crediting period".

Regarding the grid emission factor, the provisions in the latest approved version of "Tool to calculate the emission factor for an electricity system" should be applied.

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.

[5] 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 / Parameter:	$EG_{cap,m,}$ $HG_{cap,m}$
Data unit:	MW or TJ/hr
Description:	Design capacity of energy plant *m* in the peer group
Source of data:	Nameplate information on the installed capacity of energy plant *m* in the peer group
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter:	Y_m
Data unit:	year
Description:	Year of commissioning of energy plant *m* in the peer group
Source of data:	Plant records or official documentation
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter:	$EF_{CO2,m}$
Data unit:	t CO_2/TJ
Description:	CO_2 emission factor of the fuel(s) used in energy plant *m* in the peer group
Source of data:	Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default emission factors (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the value in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards
Any comment:	The lowest CO_2 emission factor should be used in case of multi fuel plants

Data / Parameter:	η_m
Data unit:	fraction
Description:	Design efficiency of energy plant m in the peer group
Source of data:	Manufacturer's information on the efficiency of the technology used by energy plant *m* in the peer group. If the actual manufacturer's information is not available, the efficiency may be estimated conservatively by another manufacturer, taking into account the fuel and the capacity
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter:	$EG_{cap,i,j}$
Data unit:	MWh/yr
Description:	Historical maximum of electricity generation of existing fossil fuel fired captive power plant *j* at the site of project customer *i*
Source of data:	Plant records
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter:	$FC_{i,j,k}$
Data unit:	Mass or volume unit
Description:	Quantity of fossil fuel type *k* fired in captive power plant *j* in the year prior to the implementation of the project activity
Source of data:	Plant records
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter:	$NCV_{i,j,k}$
Data unit:	GJ/mass or volume unit
Description:	Net calorific value of fossil fuel type *k* fired in captive power plant *j*
Source of data:	Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default net calorific values (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the values in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards, from the same year as the information on the electricity generation
Any comment:	---

Data / Parameter:	$EF_{CO2,k}$
Data unit:	t CO_2/GJ
Description:	CO_2 emission factor of fossil fuel type *k*
Source of data:	Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default emission factors (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the value in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards, from the same year as the information on the electricity generation
Any comment:	The lowest CO_2 emission factor should be used in the case of multi fuel plants

Data / Parameter:	$EG_{i,j}$
Data unit:	MWh/yr
Description:	Quantity of electricity generated in captive power plant *j* at the site of project customer *i* in the year prior to the implementation of the project activity
Source of data:	Plant records of on-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Any comment:	---

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e/tCH_4
Description:	Global warming potential of methane valid for the relevant commitment period
Value to be applied:	Default value of 21 for the first commitment period under the Kyoto Protocol
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$EF_{NG,upstream,CH4}$
Data unit:	t CH_4/GJ
Description:	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system
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. Where such data is not available, project participants should use the default values provided in the Table 2 in the baseline methodology
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$EF_{CO2,upstream,LNG}$
Data unit:	t CO_2e/GJ
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 tCO2e/TJ as a rough approximation
Measurement procedures (if any):	-
Any comment:	-

III. MONITORING METHODOLOGY

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

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

Data and parameters monitored

Data / Parameter:	$EG_{GIC,y}$
Data unit:	MWh/yr
Description:	Quantity of electricity generated by the project facility that is supplied to the Greenfield industrial consumer in year *y*
Source of data:	Measurements at the consumer side
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity purchases
Any comment:	---

Data / Parameter:	$HG_{GIC,y}$
Data unit:	TJ/yr
Description:	Quantity of steam/heat generated by the project facility that is supplied to the Greenfield industrial consumer in year *y*
Source of data:	Measurements on the consumer side
Measurement procedures (if any):	This parameter should be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water and the boiler blow-down. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	---
Any comment:	The DOE shall ensure the compliance of the applicability condition on heat-to-power ratio for each monitoring period, by comparing $HG_{GIC,y}$ (converted to MWh/yr) to the sum of $EG_{GIC,y}$, $EG_{PC,i,y}$, and $EG_{Grid,y}$.

Data / Parameter:	$EG_{PC,i,y}$
Data unit:	MWh/yr
Description:	Quantity of electricity generated by the project facility that is supplied to project customer *i* in year *y*
Source of data:	Measurements at the customer site
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity purchases
Any comment:	The DOE shall also confirm that electricity is only supplied to the grid and/or the project customers as identified ex ante in the PDD. If ex post power is supplied to any customer not identified in the registered PDD, then the latest version of the "Procedures for notifying and requesting approval of changes from the project activity as described in the registered PDD" shall be followed.

Data / Parameter:	$EG_{Grid,y}$
Data unit:	MWh/yr
Description:	Quantity of electricity generated by the project facility that is supplied to the grid in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales
Any comment:	---

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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Annex 1: Procedure for the identification of the reference energy plants

This annex describes the procedure for defining the reference energy plants (including the reference boiler and the reference captive power plant) and their key characteristics such as fuel type and efficiency. The technology and fuel of the reference energy plants should be demonstrated to be commonly installed to supply heat or power to a new industrial facility in the relevant industrial sector in the relevant country or region and should be identified among those which provide the same level of service (i.e. the same power and heat quantity).

The following steps can be followed by the project participants to identify the reference energy plant, i.e. the reference boiler or the reference captive power plant:

Step I: Definition of similar plants to the project activity

The group of similar energy plants should consist of all the energy plants:

- That have been constructed in the previous five years;
- That have a comparable size to the project activity, defined as the range from 50% to 150% of the rated capacity of the project plant;
- That supplies at least 50% of its energy output to the same industrial sector as the Greenfield industrial consumer; and
- That are not registered CDM project activities.

Step II: Definition of the geographical area

The geographical area to identify similar energy plants should be chosen in a manner that the total number of energy plants in the peer group comprises at least 5 plants. If the number of similar plants, as defined in Step 1, within the host country is less than 5, the geographical area should be extended by including all neighbouring non-Annex I countries. If the number remains to be less than 5, then the geographical area should be further extended to include all non-Annex I countries in the continent.

If the group of similar plants is still unable to include at least 5 plants, broaden the industrial sector to include other sectors where both steam and power is utilized.

Step III: Documentation of the design parameters of the energy plants in the peer group

The following information shall be obtained and documented in the PDD for each plant in the peer group, i.e. the group of similar energy plants in the list from Step 2:

- Design capacity of the energy plant (MW or TJ/hr), $EG_{cap,m}$ or $HG_{cap,m}$;
- Year of commissioning, Y_m;
- Design efficiency from the manufactures, η_m;
- Fuel(s), $Fuel_m$, and its CO_2 emission factor (t CO_2/TJ), $EF_{CO2,m.}$

Step IV: Selection of the reference energy plant

Calculate the ratio (t CO_2 per MWh electricity generated, or t CO_2 per TJ steam produced) from the CO_2 emission factor of its fuel and the design efficiency for each energy plant *m*, and select the energy plant with the lowest ratio as the reference captive power plant or the reference boiler.

In cases where no such plant exists within the country and the procedure above can not be applied, the economically most attractive technology and fuel type should be identified among those that provide the same level of service (i.e. the same power and heat capacity), that are technologically available and that are in compliance with relevant regulations. The efficiency of the technology should be selected in a conservative manner, i.e. where several technologies could be used and are similarly economically attractive, the most efficient technology should be considered.

The fuel used in the reference plant should be selected on the basis of common practices in the sector and the country (e.g. diesel generating sets may be the common practice for captive power generation in industries in the host country) and the least carbon intensive fuel type should be chosen in case of multiple fuels being possible choices.

History of the document

Version	Date	Nature of revision(s)
01.0.0	EB 66, Annex # 2 March 2012	To be considered at EB 66.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		