Draft consolidated baseline and monitoring methodology ACM00XX

"Consolidated baseline methodology for GHG emission reductions for waste gas or waste heat or waste pressure based energy system"

Source

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

- ACM0004: "Consolidated baseline methodology for waste gas and/or heat and/or pressure for power generation" based on:
  - NM0031-rev: "OSIL - 10 MW Waste Heat Recovery Based Captive Power Project, India," whose baseline study, monitoring and verification plan and project design document were prepared by Experts and Consultants of OSIL;
  - NM0087: "Baseline methodology for electricity generation using waste heat recovery in sponge iron plants", prepared by Agrienergy Ltd, Shri Bajrang Power and Ispat Ltd;
  - NM0088: "Baseline methodology for electricity production from waste energy recovery in an industrial manufacturing process", prepared by EcoSecurities B.V. and Groupe Office Cherifien des Phosphates.
- AM0032: "Baseline methodology for waste gas or waste heat based cogeneration system", based on NM0107-rev methodology "Baseline methodology for waste gas based cogeneration system for power and steam generation" prepared by Alexandria Carbon Black Co.
- NM0179: "Waste Gas and/ or Waste Heat Utilization for 'Process Steam' generation or 'Process Steam and Power'" prepared by Tata Steel.

The consolidated baseline methodology also uses some elements of the following proposed new methodologies:

- NM0155-rev: "Baseline and monitoring methodology for waste gas and/or heat utilisation" prepared by Reliance Industries Limited.
- NM0192-rev: "Baseline and Monitoring Methodology for the recovery and utilization of waste gas in refinery facilities" submitted by EcoSecurities Netherlands B.V. and YPF S.A.

For more information regarding the proposals and their consideration by the Executive Board please refer to http://cdm.unfccc.int/goto/MPappmeth

This methodology also refers the approved methodology ACM0002, "*Consolidated baseline methodology for grid-connected electricity generation from renewable sources"* and to the latest version of the "*Tool for the demonstration and assessment of additionality*"[1]

The selected approach from paragraph 48 of the CDM modalities and procedures is:

"Existing actual or historical emissions, as applicable"

Or

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

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

Definitions

For the purpose of this methodology the following definitions apply:

Cogeneration: The production of electricity and useful thermal energy simultaneously from a common fuel source using topping cycle with steam turbine. The fuel is burned in a boiler to produce high temperature and pressure steam, which powers a turbine that drives an electrical generator. A portion of the energy in the steam is converted to electrical energy, and the remaining thermal energy is available for use in an industrial process;

Waste Gas/Heat: by-product gas/heat of machines and technical processes for which no useful application is found in the absence of the project activity and for which it can be demonstrated that it has not been used prior to, and would not be used in absence of the CDM project activity. Waste gases[2] are wasted with a low energy level in several of the processing units and in normal operational processes are diverted to the flares. This is because recovering them for energy use is not feasible in the baseline scenario (e.g. because of low pressure, heating value or quantity available). In the project scenario, this waste gas is recovered to achieve a condition that makes it useful as a fuel.

Recipient Plant: plant that receives energy (electricity and/or heat) from the energy generator.

Industrial facility: The industrial facility where the waste gas is generated.

Applicability

The consolidated methodology is for project activities that utilize waste gas and/or waste heat (henceforth referred to as waste gas/heat) as an energy source for:

- Cogeneration; or
- Generation of electricity; or
- Direct use as process heat source; or
- For generation of heat in element process[3] (e.g. steam, hot water, hot oil, hot air);

And is applicable under the following conditions:

- Energy generated in the project activity may be used within the industrial facility or exported outside the industrial facility;
- The electricity generated in the project activity may be exported to the grid;

[2] Refinery gas, as opposed to waste gas, is produced generally from the light ends distillation units of refinery facilities, where it has a pressure level that allows its immediate use.
[3] An "*element process*" is defined as fuel combustion or heat utilized in equipment at one point of an industrial facility, for the purpose of providing thermal energy (the fuel is not combusted in the *element process* for electricity generation or is not used as oxidant in chemical reactions or otherwise used as feedstock). Examples of an element process are steam generation by a boiler and hot air generation by a furnace. Each element process should generate a single output (such as steam or hot air) by using mainly a single fuel (not plural energy sources). For each element process, energy efficiency is defined as the ratio between the useful energy (the enthalpy of the steam multiplied with the steam quantity) and the supplied energy to the element process (the net calorific values of the fuel multiplied with the fuel quantity).

- Energy in the project activity can be generated by the owner of the industrial facility producing the waste gas/heat or by a third party (e.g. ESCO) within the industrial facility.

- Regulations do not constrain the industrial facility generating waste gas from using the fossil fuels being used prior to the implementation of the project activity.

- The methodology covers both new and existing facilities. For existing facilities, the methodology applies to existing capacity. If capacity expansion is planned, the added capacity must be treated as a new facility.

- The waste gas utilized in the project activity was flared or released into the atmosphere in the absence of the project activity. This shall be proven by either one of the following:[4]

  - By **direct measurements** of energy content and amount of the waste gas for at least *three years* prior to the start of the project activity. Facilities that have been put in operation less than *three years* before the project activity starts are treated as new facilities.

  - **Energy balance** of relevant sections of the plant to prove that the waste gas/heat was not a source of energy before the implementation of the project activity. For the energy balance the representative process parameters are required. The energy balance must demonstrate that the waste gas/heat was not used and also provide conservative estimations of the energy content and amount of waste gas/heat released.

  - **Energy bills** (electricity, fossil fuel) to demonstrate that all the energy required for the process (e.g. based on specific energy consumption specified by the manufacturer) has been procured commercially. Project participants are required to demonstrate through the financial documents (e.g. balance sheets, profit and loss statement) that no energy was generated by waste gas and sold to other facilities and/or the grid. The bills and financial statements should be audited by competent authorities.

  - **Process plant** manufacturer's original specification/information, schemes and diagrams from the construction of the facility could be used as an estimate of quantity and energy content of waste gas/heat produced for rated plant capacity/per unit of product produced.

  - On site checks by DOE prior to project implementation can check that no equipment for waste gas recovery and use has been installed prior to the implementation of the CDM project activity.

- The credits are claimed by the generator of energy using waste gas/heat.

  - In case the energy is exported to other facilities an agreement is signed by the owner's of the project energy generation plant (henceforth referred to as generator, unless specified otherwise) with the recipient plant(s) that the emission reductions would not be claimed by recipient plant(s) for using a zero-emission energy source.

- For those facilities and recipients, included in the project boundary, which prior to implementation of the project activity (current situation) generated energy on-site (sources of energy in the baseline), the credits can be claimed for minimum of the following time periods:

  - The remaining lifetime of equipments currently being used; and

  - Credit period.

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[4] If it cannot be demonstrated through *procedures listed in sub-bullets* that the waste gas has been flared/combusted or released into atmosphere the project proponent can propose a procedure for indirect measurements (in the context of specific industrial applications) as a revision to the methodology.

- Waste gas that is released under abnormal operation (emergencies, shut down) of the plant shall not be accounted for.
- Cogeneration of energy is from combined heat and power and not combined cycle mode of electricity generation.

Project Boundary

The geographical extent project boundary shall include the following:

1. The industrial facility where waste gas is generated (generator of waste gas);
2. The facility where process heat/steam/electricity are generated (generator of process heat/steam/electricity). Equipment providing auxiliary heat to the waste heat recovery process shall be included within the project boundary; and
3. The facility/s where the process heat/steam/electricity is used (the recipient plant(s)) and/or grid where electricity is exported, if applicable.

Spatial extent of the grid is as defined in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).

Overview of emission sources included in or excluded from the project boundary is provided in the following table:

Table 1: Summary of gases and sources included in the project boundary, and justification explanation where gases and sources are not included.

	Source	Gas	Included ?	Justification / Explanation
Baseline	Electricity generation, grid or captive source	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Fossil fuel consumption in boiler for thermal energy	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Fossil fuel consumption in cogeneration plant	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.

	Baseline emissions from generation of steam used in the flaring process, if any	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	Supplemental fossil fuel consumption at the project plant	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.
	Supplemental electricity consumption.	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.
	Project emissions from cleaning of gas	CO_2	Included	Only in case waste gas cleaning is required and leads to emissions related to the energy requirement of the cleaning.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

Identification of the baseline scenario

The baseline scenario is identified as the most plausible baseline scenario among all realistic and credible alternative(s).

Realistic and credible alternatives should be determined for:

- Waste gas/heat use in the absence of the project activity; and
- Power generation in the absence of the project activity; and
- Steam/heat generation in the absence of the project activity

Multiple sub-systems generating energy in the project activity scenario

The steam and/or power requirement of the system(s) in the project boundary should be determined, which can be met from one or more than one sub-system(s) in the project activity scenario. While determining the baseline scenario, project participants shall identify the realistic and credible alternatives to the project activity, which would provide output equivalent to the combined output of the all the sub-systems in the project activity scenario. These alternatives may comprise of one system or more than one sub-system(s). Therefore the alternatives, identified for the project activity, should provide the same steam and/or power output as in the project activity scenario and should include the alternate use of the waste gas heat utilized in the project activity. These alternatives shall be determined as suitable combinations of the following options available for meeting the 'steam requirement' and/or 'power requirement' and for ensuring 'alternate use of waste gas and/or waste heat' as described below:

The project participant shall exclude baseline options that:

- Do not comply with legal and regulatory requirements; or
- Depend on fuels (used for generation of heat and/or power), that are not available at the project site

The project participant shall provide evidence and supporting documents to exclude baseline options that meet the above-mentioned criteria.

Step 1: Define the most plausible baseline scenario for the generation of heat and electricity using the following baseline options and combinations.

The baseline candidates should be considered for following facilities:

- For the industrial facility where the waste gas is generated; and
- For the facility where the energy is produced; and
- For the facility where the energy is consumed.

For the use of waste gas, the realistic and credible alternative(s) may include, *inter alia*:

W1 Waste gas is directly vented to atmosphere without incineration;

W2 Waste gas is released to the atmosphere after incineration or waste heat is released to the atmosphere;

W3 Waste gas/heat is sold as an energy source;

W4 Waste gas/heat is used for meeting energy demand.

For power generation, the realistic and credible alternative(s) may include, *inter alia*

P1 Proposed project activity not undertaken as a CDM project activity;

P2 On-site or off-site existing/new fossil fuel fired cogeneration plant[5];

P3 On-site or off-site existing/new renewable energy based cogeneration plant[6];

P4 On-site or off-site existing/new fossil fuel based existing captive or identified plant;

P5 On-site or off-site existing/new renewable energy based existing captive or identified plant;

P6 Sourced Grid-connected power plants;

P7 Captive Electricity generation from waste gas (if project activity is captive generation with waste gas, this scenario represents captive generation with lower efficiency than the project activity.);

P8 Cogeneration from waste gas (if project activity is cogeneration with waste gas, this scenario represents cogeneneration with lower efficiency than the project activity).

For heat generation, realistic and credible alternative(s) may include, *inter alia*:

H1 Proposed project activity not undertaken as a CDM project activity;

H2 On-site or off-site existing/new fossil fuel based cogeneration plant[6];

H3 On-site or off-site existing /new renewable energy based cogeneration plant[7];

[5] Scenarios P2 and H2 are related to the same fossil fuel cogeneration plant.
[6] Scenarios P3 and H3 are related to the same renewable energy based cogeneration plant.

H4 An existing or new fossil fuel based boilers;

H5 An existing or new renewable energy based boilers;

H6 Any other source such as district heat;

H7 Other heat generation technologies (e.g. heat pumps or solar energy);

H8 Steam/ Process heat generation from waste gas, but with lower efficiency;

H9 Cogeneration from waste gas, but with lower efficiency.

The generator of energy, in consultation with the waste gas generator(s) and recipient plant(s), where applicable, shall consider the above baseline options to develop a scenario matrix based on various combinations of baseline options. Exclusion of any baseline options shall be justified with documented evidence.

STEP 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.

Demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint.

Detailed justification shall be provided for the selected baseline fuel. As a conservative approach, the available fuel with the lowest carbon emission factor (e.g., natural gas) shall be used.

In case of partial supply constraints (seasonal supply), the project participants shall consider the available alternative fuel that result in lowest baseline emissions during the period of partial supply.

STEP 3:

Step 2 and/or step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality" shall be used to identify the most plausible baseline scenarios by eliminating non-feasible options (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive).

STEP 4: If more than one credible and plausible alternative scenario remain, the alternative with the lowest baseline emissions shall be considered as the most likely baseline scenario.

The information of baseline for utilisation of heat (or steam) and electricity will be received from recipient plant(s) and the information on utilisation of waste gas in baseline will be received from generator(s) of waste gas. Hence generator of heat/steam/electricity, who is the CDM project proponent, shall determine baseline options, identify most appropriate baseline scenario, determine baseline fuel and demonstrate and assess additionality in consultation with the recipient plant(s) and waste gas generator(s). For this purpose, the waste gas generator(s) and recipient plant(s) that consume steam and/or electricity shall be identified at the time of preparation of PDD. The consultations with waste gas generator(s) and recipient plant(s) shall be documented.

This methodology is only applicable if the baseline scenario, for all the waste gas generator(s) and the recipient plant(s) identified, is one of the two scenarios described in Table 1 below. If the methodology is to be applicable where the waste/gas is used for generating one form of energy only (electricity or heat), then the baseline too should be only generation of one form of energy (electricity or heat respectively).

Table 1: Combinations of baseline options and scenarios applicable to this methodology

Project Scenario: Cogeneration of energy				
Scenario	Baseline options			Description of situation
	Waste gas	Power	Heat	
1	W2	P4 or P6	H4	The electricity is obtained from an specific existing plant[7] or from the grid and heat from a fossil fuel based steam boiler
2	W2	P2	H2	The electricity and/or heat are generated by a fossil fuel based existing[8] / new cogeneration plant. All the recipient of project energy would have been provided energy from a common fossil fuel based cogeneration source in absence of the project activity.

Project Scenario: Generation of Electricity or Heat only			
Scenario	Baseline options		Description of situation
	Waste gas	Power/ Heat	
1	W2	P4 or P6/ H4	The electricity is obtained from an specific existing plant[9] or from the grid and heat from a fossil fuel based steam boiler

Additionality

Option 1:

The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, available at the UNFCCC CDM website[10].

For new facilities or cases where the user of waste gas is a different company than the waste gas generator (e.g., ESCO running a project in an industrial facility) step 2 of the latest **"**Tool for the demonstration and assessment of additionality" must be used to demonstrate additionality.

Option 2:

The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, available at the UNFCCC CDM website[11].

[7] In case operation of an existing plant is identified as the baseline scenario, the remaining lifetime of the existing plant shall be larger than the crediting period chosen.
[8] In case operation of an existing cogeneration plant is identified as the baseline scenario, the remaining lifetime of the existing plant shall be larger than the crediting period chosen.
[9] In case operation of an existing plant is identified as the baseline scenario, the remaining lifetime of the existing plant shall be larger than the crediting period chosen.
[10] Please refer to: http://cdm.unfccc.int/goto/MPappmeth
[11] Please refer to: http://cdm.unfccc.int/goto/MPappmeth

Baseline Emissions

The baseline emissions for the year *y* shall be determined as follows:

$$BE_y = BE_{En,y} + BE_{flst,y} \quad \textbf{(1)}$$

Where:

BE_y are total baseline emissions during the year *y* in tons of CO_2

$BE_{En,y}$ are baseline emissions from energy generated by project activity during the year *y* in tons of CO_2

$BE_{flst,y}$ Baseline emissions from generation of steam, if any, using fossil fuel, that would have been used for flaring the waste gas in absence of the project activity (tCO2e per year), calculated as per equation 1c. This is relevant for those project activities where in the baseline steam is used to flare the waste gas.

The calculation of baseline emissions ($BE_{En,y}$) depends on the identified baseline scenario.

Baseline emissions for Scenario 1

Scenario 1 represents the situation where the electricity is obtained from a specific existing plant or from the grid and heat from a fossil fuel based steam boiler.

NOTE: If the project activity is either *generation of electricity only* or *generation of heat only*, then one of the two sub-sections below shall be used for estimating baseline, depending on the type of energy generated by the project activity.

$$BE_{En,y} = BE_{Elec,y} + BE_{Ther,y} \quad \textbf{(1a)}$$

$BE_{Elec,y}$ are baseline emissions from electricity during the year *y* in tons of CO_2

$BE_{Ther,y}$ are baseline emissions from thermal energy (due to steam and/or process heat) during the year *y* in tons of CO_2

a) Baseline emissions from electricity ($BE_{electricity,y}$) that is displaced by the project activity:

$$BE_{Elec,y} = f_{cap} * f_{wg} * \sum_j \sum_i ((EG_{i,j,y} * EF_{Elec,i,j,y}) \quad \textbf{(1a-1)}$$

Where:

$BE_{elec,y}$ are baseline emissions due to displacement of electricity during the year *y* in tons of CO_2.

$EG_{i,j,y}$ is the quantity of electricity supplied to the recipient *j* by generator, which in the absence of the project activity would have been sourced from i^{th} source (*i* can be either grid or identified source) during the year *y* in MWh, and

$EF_{elec,i,j,y}$ is the CO_2 emission factor for the electricity source i (i=gr (grid) or i=is (identified source)), displaced due to the project activity, during the year *y* in tons CO_2/MWh

f_{wg} Fraction of total electricity generated by the project activity using waste gas. This fraction is 1 if the electricity generation is purely from use of waste gas. If the boiler providing steam for electricity generation uses both waste and fossil fuels, this factor is estimated using equation (1d). If the steam used for generation of the electricity is produced in dedicated boilers but supplied through common header, this factor is estimated using equation (1d/1e).

f_{cap} Energy that would have been produced in project year y using waste gas/heat generated in base year expressed as a fraction of total energy produced using waste gas in year y. The ratio is 1 if the waste gas generated in project year y is same or less then that generated in base year. The value is estimated using equation (1f).

The proportion of electricity that would have been sourced from the i^{th} source to the j^{th} recipient plant should be estimated based on historical data of the proportion received during the three most recent years.

If the baseline generation source is an identified existing/new plant, the CO_2 emission factor shall be determined as follows:

$$EF_{Elec,is,j,y} = \frac{EF_{CO2,is,j}}{3.6 * 10^{-3} * \eta_{Plant,j}} \qquad \textbf{(1a-11)}$$

Where:

$EF_{CO2,is,j}$ is the CO_2 emission factor per unit of energy of the fossil fuel *used* in the baseline generation source *i* in (tCO_2 / TJ), o*btained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors*

$\eta_{Plant,j}$ is the overall efficiency of the existing plant that would be used by j^{th} recipient in the absence of the project activity.

Efficiency of the power plant *($\eta_{plant,j}$)* shall be one of the following:

i) Assume a constant efficiency of the captive plant and determine the efficiency, as a conservative approach, for optimal operation conditions (i.e. optimal load, optimal oxygen content in flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, including temperature and humidity, etc); or

ii) Highest of the efficiency values provided by two or more manufacturers for power plants with specifications similar to that that would have been required to supply the recipient with electricity that it receives from the project activity; or

iii) Assume a captive power generation efficiency of 60% based on the net calorific values as a conservative approach; or

iv) Estimated from load v/s efficiency curve established through measurement and described in Annex I.

If the displaced electricity for recipient is supplied by a connected grid system, the CO_2 emission factor of the electricity $EF_{elec,gr,j,y}$ shall be determined following the guidance provided in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources (ACM0002)". If the total electricity generated by project activity is less than 60 GWh/year, then, project proponents can use approved small scale methodology AMS I.D to estimate the grid emission factor.

b) Baseline emissions from thermal energy ($BE_{ther,y}$):

$$BE_{Ther,y} = f_{cap} * f_{WG} * \sum_j HG_{j,y} \cdot EF_{Steam,j,y} \qquad \textbf{(1a-2)}$$

Where:

$BE_{Ther,y}$	are baseline emissions from thermal energy (as steam) during the year *y* in tons of CO_2
$HG_{j,y}$	is the net quantity of heat supplied to the recipient plant j by the project activity during the year *y* in TJ, expressed as difference of energy content between the steam supplied to the recipient plant and the condensate returned by the recipient plant
f_{wg}	Fraction of total heat generated by the project activity electricity using waste gas. This fraction is 1 if the heat generation is purely from use of waste gas. If the boiler providing steam for heat generation uses both waste and fossil fuels, this factor is estimated using equation (1d/1e).
f_{cap}	Energy that would have been produced in project year y using waste gas/heat generated in base year expressed as a fraction of total energy produced using waste gas in year y. The ratio is 1 if the waste gas generated in project year y is same or less then that generated in base year. The value is estimated using equation (1f).
$EF_{Steam,j,y}$	is the CO_2 emission factor of the steam source that would have supplied the recipient plant j in absence of the project activity, expressed in tCO_2/TJ and calculated as follows:

$$EF_{Steam,j,y} = \sum_i ws_{i,j} \frac{EF_{CO2,i,j}}{\eta_{Boiler,i,j}} \qquad \textbf{(1a-21)}$$

Where:

$EF_{CO2,i,j}$	is the CO_2 emission factor per unit of energy of the baseline fuel used in i^{th} boiler used by recipient j , in tCO_2/TJ, in absence of the project activity
$\eta_{Boiler,i,j}$	is efficiency of the i^{th} boiler that would have been supplied heat to j^{th} recipient in the absence of the project activity
$ws_{i,j}$	fraction of total steam that is used by the recipient j in the project that in absence of the project activity would have been supplied by the i^{th} boiler.

Efficiency of the boiler *($\eta_{Boiler,i,j}$)* shall be one of the following:

i) Assume a constant efficiency of the boiler and determine the efficiency, as a conservative approach, for optimal operation conditions (i.e. optimal load, optimal oxygen content in flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, including temperature and humidity, etc); or

ii) Highest of the efficiency values provided by two or more manufacturers for boilers with specifications similar to that would have been required to supply the recipient with heat that it receives from the project activity; or

iii) Maximum efficiency of 100%.

iv) Estimated from load v/s efficiency curve established through measurement and described in Annex I.

Baseline emissions for Scenario 2

Scenario 2 represents the situation where the recipient plant(s) obtains electricity and/or heat generated by a fossil fuel based existing/ new cogeneration plant.

NOTE: This option is only for those project activities that co generate electricity and heat.

Baseline emissions from co generated electricity and heat of a cogeneration plant are calculated by multiplying electricity *($EG_{j,y}$)* and heat (steam) supplied ($HG_{j,y}$) to the recipient plant(s) with the CO_2 emission factor of the fuel used by the cogeneration plant that would have supplied all the recipient plants j of energy in the absence of the project activity, as follows:

$$BE_{En,y} = f_{cap} * f_{WG} * \sum_{j} \frac{(HG_{j,y} + EG_{j,y} * 3.6 * 10^{-3})}{\eta_{Cogen}} * EF_{CO2,COGEN} \quad \textbf{(1b)}$$

Where:

$BE_{En,y}$	are the baseline emissions from energy that is displaced by the project activity during the year *y* in tons of CO_2.
$EG_{j,y}$	is the quantity of electricity supplied to the recipient plant j by the project activity during the year *y* in MWh
$3.6*10^{-3}$	conversion factor, expressed as TJ/MWh
$HG_{j,y}$	is the net quantity of heat supplied to the recipient plant j by the project activity during the year *y* in TJ, expressed as difference of energy content between the steam supplied to the recipient plant and the condensate returned by the recipient plant(s)
$EF_{CO2,COGEN}$	is the CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline cogeneration plant , in (tCO_2 / TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors
η_{Cogen}	is the efficiency of cogeneration plant (combined heat and power efficiency) using fossil fuel that would have been used in the absence of the project activity.
f_{wg}	Fraction of total energy generated by the project activity using waste gas. This fraction is 1 if the energy generation is purely from use of waste gas in the project generation unit. If the generation unit uses steam from both waste and fossil fuels, this factor is estimated using equation (1d/1e).
f_{cap}	Energy that would have been produced in project year y using waste gas/heat generated in base year expressed as a fraction of total energy produced using waste gas in year y. The ratio is 1 if the waste gas generated in project year y is same or less then that generated in base year. The value is estimated using equation (1f).

Efficiency of the cogeneration plant, *(η_{Cogen})* shall be one of the following:

i) Assume a constant efficiency of the cogeneration plant and determine the efficiency, as a conservative approach, for optimal operation conditions (i.e. optimal load, optimal oxygen content in flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, including temperature and humidity, etc); or

ii) Highest of the efficiency values provided by two or more manufacturers for similar plants, as used in the project activity; or

iii) Maximum efficiency of 90%, based on net calorific values.

iv) Estimated from load v/s efficiency curve established through measurement and described in Annex I.

Baseline emissions from generation of steam, using fossil fuel, that would have been used in the flaring of waste gas in absence of the project activity ($BE_{flst,y}$)

$$BE_{flst,y} = \sum_j Q_{ff,st,y} * EF_{CO2,j} \quad \textbf{(1c)}$$

Where:

$Q_{ff,st,y}$ Estimated amount of fossil fuel that would have been needed in industrial facility either directly or to generate steam that would have been used to flare waste gas, generated in year, in absence of the project activity (TJ).

$EF_{CO2,j}$ CO_2 emission factor of fossil fuel (tCO_2/TJ) that would have been used at facility '*j*'.

In case steam is used instead of fossil fuel directly, the fossil fuel consumed can be estimated as follows:

$$Q_{ff,st,y} = \frac{(Q_{WG,y}) * SF_{WG}}{\eta_{Boiler,fl}} \quad \textbf{(1c-1)}$$

Baseline emissions from use of fossil fuel (oil, gas) for flaring process in year *y* (tCO_2e per year)

$Q_{WG,y}$ Quantity of waste gas used for energy generation during year y (Nm^3)

SF_{WG} Steam required per unit of waste gas flared, in terms of energy content, (TJ/unit waste gas)

$\eta_{Boiler,fl}$ Efficiency of the boiler that would have been used to generate the steam in absence of the project activity. The guidelines for determining the efficiency for baseline boiler shall be used to determine this efficiency.

$$SF_{WG} = \frac{Q_{st,fl,B}}{Q_{WG,Fl,B}} \quad \textbf{(1c-11)}$$

$Q_{WG,Fl,B}$ The amount of waste gas flared using steam prior to the implementation of the project activity (Nm^3). Preferably three years historic data shall be used and at least one-year historic data should be used.

$Q_{st,fl,B}$ Steam used to flare the waste gas prior to the implementation of the project activity (TJ). Preferably three years historic data shall be used and at least one-year historic data should be used.

Calculation of the energy generated in units supplied by waste gas and other fuels

Situation 1

The procedure specified below, should be applied when the direct measurement of the energy generated by using the waste gas is not possible as other fossil fuel(s) along with waste gas are used for energy generation. The relative share of the total generation from waste gas is calculated by considering the total electricity produced, the amount and caloric values of the other fuels and of the waste gas used, and the average efficiency of the plants where the energy is produced.

The fraction of energy produced by using the waste gas in the project activity is calculated as follows:

$$f_{WG} = \frac{\left(\frac{\sum_{h=1}^{8760} Q_{WG,h} * NCV_{WG}}{H_r}\right)}{EG_{tot,y}} \qquad \textbf{(1d)}$$

Where:

$Q_{WG,h}$	Amount of WG recovered (Nm^3/h)
NCV_{WG}	Net Calorific Value of Waste Gas (TJ/Nm^3)
Hr	Average efficiency as calculated in equation 1d-1 below.

The average efficiency is given as:

$$H_r = \frac{\sum_{h=1}^{8760}\sum_{i=1}^{I} Q_{i,h} * NCV_i}{EG_{tot,y}} \qquad \textbf{(1d-1)}$$

Where:

$Q_{i,h}$	Amount of individual fuel (waste gas and other fuel(s)) i consumed at the energy generation unit during hour h (Nm^3/h)
NCV_i	Net Calorific Value annual average for each individual consumed fuel and the waste gas (TJ/Nm^3)
$EG_{tot,y}$	Total annual energy produced at the power plants. (TJ/year)

Situation 2

An alternative method that could be used when it is not possible to measure the net calorific value of the waste gas/heat, and steam generated with different fuels in dedicated boilers are fed to a single turbine takes into account that the relative share of the total generation from waste gas is calculated by considering the total electricity produced and the amount of steam generated form each boiler. The fraction of energy produced by the project activity is calculated as follows:

$$f_{WG} = \frac{ST_{whr,y}}{ST_{whr,y} + ST_{other,y}} \qquad \textbf{(1e)}$$

Where:

$ST_{whr,y}$	Energy content of the steam generated in waste heat recovery boiler fed to turbine via common steam header
$ST_{other,y}$	Energy content of steam generated in other boilers fed to turbine via common steam header

Method 2 requires that:

- All the boilers have to provide superheated steam.

- The calculation should be based on the energy supplied to the steam turbine. The enthalpy and the steam flow rate must be monitored for each boiler to determine the steam energy content. The calculation implicitly assumes that the properties of steam (temperature and pressure) generated from different sources are the same. The enthalpy of steam and feed water will be determined at measured temperature and pressure and the enthalpy difference will be multiplied with quantity measured by steam meter.
- Any vented steam should be deducted from the steam produced with waste gas/heat.

Capping of baseline emissions

As an introduction of element of conservativeness, this methodology requires that baseline emissions should be capped irrespective of planned/ unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuels type and quantity resulting into increase in waste gas generation. In case of planned expansion a separate CDM project should be registered for additional capacity. The baseline emissions are capped at the maximum quantity of waste gas flared/combusted or waste heat released into the atmosphere under normal operation conditions in the 3 years previous to the project activity.

For that purpose f_{cap} is estimated as follows:

$$f_{cap} = \frac{Q_{WG,BL}}{Q_{WG,y}} \quad \textbf{(1f)}$$

Where:

$Q_{WG,BL}$ Quantity of waste gas generated prior to the start of the project activity. (Nm^3)

$Q_{WG,y}$ Quantity of waste gas used for energy generation during year y (Nm^3)

Project Emissions

Project Emissions include emissions due to combustion of auxiliary fuel to supplement waste gas.

$$PE_y = PE_{AF,y} \tag{2}$$

Where:

PE_y	Project emissions due to project activity.
$PE_{AF,y}$	Project activity emissions from on-site consumption of fossil fuels by the cogeneration plant(s), in case they are used as supplementary fuels, due to non-availability of waste gas to the project activity or due to any other reason.

Project emissions due to auxiliary fossil fuel are calculated by multiplying the quantity of fossil fuels *($FF_{i,y}$)* used by the recipient plant(s) with the CO_2 emission factor of the fuel type *i* *($EF_{CO2,i}$)*, as follows:

$$PE_{AF,y} = \sum FF_{i,y} \cdot NCV_i \cdot EF_{CO2,i} \cdot \tag{2a}$$

Where:

$PE_{AF,y}$	are the emissions from the project activity in year y due to combustion of auxiliary fuel in tonnes of CO_2
$FF_{i,y}$	is the quantity of fossil fuel type *i* combusted to supplement waste gas in the project activity during the year *y,* in energy or mass units
NCV_i	is the net calorific value of the fossil fuel type *i* combusted as supplementary fuel, in TJ per unit of energy or mass units, obtained from reliable local or national data, if available, otherwise taken from the country specific IPCC default factors
$EF_{CO2,i}$	is the CO_2 emission factor per unit of energy or mass of the fuel type *i* in tons CO_2 obtained from reliable local or national data, if available, otherwise taken from the country specific IPCC default factors

The above procedure for project emissions estimation apply for all types of project activities covered under this methodology.

Leakage

No leakage is applicable under this methodology.

Emission Reductions

Emission reductions due to the project activity during the year *y* are calculated as follows:

$$ER_y = BE_y - PE_y \tag{3}$$

Where:

ERy	are the total emissions reductions during the year *y* in tons of CO_2
PE_y	are the emissions from the project activity during the year *y* in tons of CO_2
BE_y	are the baseline emissions for the project activity during the year *y* in tons of CO_2, applicable for scenario 2.

Data and parameters not monitored

Data / parameter:	η_{BL} ($\eta_{Boiler,i,j}$, $\eta_{Plant,j}$, η_{Cogen})
Data unit:	
Description:	Baseline efficiency of the boiler/captive power plant/cogeneration plant
Source of data:	Manufacturers data or data from similar plant operators or project participants data.
Measurement procedures (if any):	Efficiency of the the boiler/captive power plant/cogeneration plant , shall be one of the following: i) Assume a constant efficiency of the boiler/captive power plant/cogeneration plant and determine the efficiency, as a conservative approach, for optimal operation conditions (i.e. optimal load, optimal oxygen content in flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, including temperature and humidity, etc); or ii) Highest of the efficiency values provided by two or more manufacturers for similar boilers/captive power plants/cogeneration plants, as used in the project activity; or iii) Maximum efficiency of 100%/60%/90%, based on net calorific values. iv) Estimated from load v/s efficiency curve established through measurement and described in Annex I.
Any comment:	

Data / parameter:	$\boldsymbol{\eta}_{BL,t}(\eta_{Boiler,i,j,t}/\eta_{Plant,j,t}/\eta_{Cogen,t})$
Data unit:	-
Description:	Baseline efficiency of the boiler/captive power plant/cogeneration plant during time interval *t* where *t* is a discrete time interval during the year *y*
Source of data:	Measurements by project participants
Measurement procedures (if any):	Establish an efficiency-load-function for the boiler/captive power plant/cogeneration plant ($\eta_{BL,t}$= f($HG_{j,}$t/$EGi_{j,t}$/$EG_{j,t}$+$HG_{j,t}$)). Use recognized standards for the measurement of the boiler efficiency, such as the "British Standard Methods for Assessing the thermal performance of boilers for steam, hot water and high temperature heat transfer fluids" (BS845) and similar relevant standards for power/cogeneration efficiency measurement. Use the direct method (dividing the net energy generation by the energy content of the fuels fired during a representative time period) and not the indirect method (determination of fuel supply or energy generation and estimation of the losses). Best practices for operation of boilers/power plant/cogeneration plant should be followed. The measurement should be supervised by a competent independent third party (e.g. the DOE). The measurement should be conducted immediately after scheduled preventive maintenance has been undertaken and under good operation conditions (optimal load, optimal oxygen content in the flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, etc). During the measurement campaign, the load is varied over the whole operation range and the efficiency is measured for different steady-state load levels. The efficiency should be measured for at least 10 different load levels covering the operation range. Apply a regression analysis to the measured efficiency for different load levels. Calculate the standard deviation of the regression, using the guidance in the Annex I to this methodology. Document the measurement procedures and results (i.e. efficiency at different load levels, application of the regression analysis) transparently in the CDM-PDD or, if undertaken during the crediting period, in the monitoring report.
Any comment:	Only applicable if measurement based load v/s efficiency curve option is chosen

Data / Parameter:	$Q_{WG,BL}$
Data unit:	
Description:	Quantity of waste gas generated prior to the start of the project activity. (Nm^3)
Source of data:	
Measurement procedures (if any):	i) By **direct measurements** of energy content and amount of the waste gas for at least *three years* prior to the start of the project activity. Facilities that have been put in operation less than *three years* before the project activity starts are treated as new facilities. **ii)Energy balance** of relevant sections of the plant to prove that the waste gas/heat was not a source of energy before the implementation of the project activity. For the energy balance the representative process parameters are required. The energy balance must demonstrate that the waste gas/heat was not used and also provide conservative estimations of the energy content and amount of waste gas/heat

	released. **iii) Process plant manufacturer's original specification/information**, schemes and diagrams from the construction of the facility could be used as an estimate of quantity and energy content of waste gas/heat produced for rated plant capacity/per unit of product produced.
Any comment:	

Data / parameter:	$Q_{WG,Fl,B}$
Data unit:	Nm^3
Description:	The amount of waste gas flared using steam prior to the implementation of the project activity. Preferably three years historic data shall be used and at least one-year historic data should be used.
Source of data:	
Measurement procedures (if any):	
Any comment:	

Data / parameter:	$Q_{st,,fl,B}$
Data unit:	TJ
Description:	Steam used to flare the waste gas prior to the implementation of the project activity. At least one year's historic data shall be used and preferably three years historic should be used. Preferably three years historic data shall be used and at least one-year historic data should be used.
Source of data:	
Measurement procedures (if any):	
Any comment:	

Monitoring Methodology

All data collected as part of monitoring plan 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 comments in the tables below. The following data shall be monitored.

Project emissions:

1. Quantity of fossil fuels used as supplementary fuel

2. Net calorific value of fossil fuel,

3. CO_2 emission factor of the fossil fuel

While the quantity of fossil fuels fired are measured using calibrated flow meters, other data items are only factors obtained from reliable local or national data. If local data is not available, project participant may use default factors published by IPCC.

Baseline Emissions:

Depending on the baseline scenario, the following data items need monitoring.

1. Quantity of electricity supplied to the recipient plant(s)
2. CO_2 emission factor of electricity that would have been consumed by the recipient plant(s) in the absence of the project activity
3. Quantity of steam supplied to the recipient plant(s)
4. Pressure and temperature of the steam supplied to the recipient plant(s)
5. Pressure and temperature of the condensate return supplied by the recipient plant(s) to the project plant
6. Efficiencies of steam boiler or cogeneration plant that would have been built in the absence of the project activity

In case the grid electricity is consumed by recipient plant(s) (Scenario 1) and the grid electricity emission factor is applicable, then relevant variables as contained in the “Consolidated monitoring methodology for zero-emission grid connected electricity generation from renewable energy sources” (ACM0002) shall be included in the monitoring plan by the project participants.

Data and parameters monitored

Data / parameter:	$FF_{i,y}$
Data unit:	NM^3 or ton
Description:	Quantity of fossil fuel type *i* combusted to supplement waste gas in the project activity during the year *y,* in energy or mass units
Source of data:	Measurement records of recipient plant(s)
Measurement procedures (if any):	
Monitoring frequency:	Continuously and aggregated monthly
QA/QC procedures:	Fuel flow meters will undergo maintenance / calibration subject to appropriate industry standards. Records of measuring devices shall ensure the data consistency. Fuel purchase records / receipts by recipient plants shall be used to verify the measured data.
Any comment:	This data item is measured in volume units or mass units depending on the type of fossil fuels used.

Data / parameter:	***NCV_i***
Data unit:	TJ/NM^3 or ton
Description:	Net calorific value of the fossil fuel *i*
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item.
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	***$ws_{i,,j}$***
Data unit:	
Description:	Fraction of total steam that is used by the recipient j in the project that in absence of the project activity would have been supplied by the i^{th} boiler.
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	

Data / parameter:	***$Q_{WG,y}$***
Data unit:	Nm^3
Description:	Quantity of waste gas used for energy generation during year y (Nm^3)
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	***$EF_{elec,i,,j,y}$***
Data unit:	tCO_2 / MWh
Description:	CO_2 emission factor for the electricity source i (i=gr (grid) or i=is (identified source)) , displaced due to the project activity, during the year *y* in tons CO_2/MWh
Source of data:	Project participants calculation sheets
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	For identified sources (is) equation (1a-11) of this methodology is used, for the grid (gr) the guidance provided in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources (ACM0002)" shall be used. If the total electricity generated by project activity is less than 60 GWh/year, then, project proponents can use approved small scale methodology AMS I.D to estimate the grid emission factor.

Data / parameter:	$EF_{CO2,is,j}$
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor per unit of energy of the fossil fuel used in the baseline generation source i (i=is) providing energy to recipient j.
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	$EF_{CO2,COGEN}$
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline cogeneration plant.
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	***$EG_{i,,j,y}$***
Data unit:	MWh
Description:	Quantity of electricity supplied to the recipient *j* by generator, which in the absence of the project activity would have sourced from i^{th} source (*i* can be either grid or identified source) during the year *y* in MWh
Source of data:	Recipient plant(s) and generation plant measurement records
Measurement procedures (if any):	
Monitoring frequency:	Monthly
QA/QC procedures:	The energy meters will undergo maintenance / calibration to the industry standards. Sales records and purchase receipts are used to ensure the consistency.
Any comment:	Data shall be measured at the recipient plant(s) and at the generation plant for cross check. Sales receipts shall be used for verification. DOEs shall verify that total energy supplied by the generator is equal to total electricity received by recipient plant(s).

Data / parameter:	***$EG_{j,y}$***
Data unit:	MWh
Description:	Quantity of electricity supplied to the recipient plant j by the project activity during the year *y* in MWh
Source of data:	Recipient plant(s) and generation plant measurement records
Measurement procedures (if any):	
Monitoring frequency:	Monthly
QA/QC procedures:	The energy meters will undergo maintenance / calibration to the industry standards. Sales records and purchase receipts are used to ensure the consistency.
Any comment:	Data shall be measured at the recipient plant(s) and at the generation plant for cross check. Sales receipts shall be used for verification. DOEs shall verify that total energy supplied by the generator is equal to total electricity received by recipient plant(s).

Data / parameter:	***$HG_{j,y}$***
Data unit:	TJ
Description:	Net quantity of heat supplied to the recipient plant j by the project activity during the year *y* in TJ, expressed as difference of energy content between the steam supplied to the recipient plant and the condensate returned by the recipient plant/during the time interval *t* where *t* is a discrete time interval during the year *y*
Source of data:	Recipient plant(s) actual measurement records
Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam or hot water generated by the boiler(s) minus the enthalpy of the feed-water, the boiler blow-down and any condensate return. 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:	Continuously, aggregated annually (in case of option A) or for each time interval *t* (in case of option B)
QA/QC procedures:	This data item is a calculated value using other data items. No QA/QC required.
Any comment:	Expressed as the difference between the steam supplied and the condensate returned, both in energy units.

Data / parameter:	***$EF_{CO2,i,j}$***
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor per unit of energy of the baseline fuel used in i^{th} boiler used by recipient j , in tCO_2/TJ, in absence of the project activity.
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	$\mathbf{Q_{ff,st,y}}$
Data unit:	TJ
Description:	Estimated amount of fossil fuel that would have been needed in industrial facility either directly or to generate steam that would have been used to flare waste gas, generated in year, in absence of the project activity (TJ
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	In case steam is used instead of fossil fuel directly, the fossil fuel consumed can be estimated with equation 1c-1.

Data / parameter:	$\boldsymbol{EF_{CO2,j}}$
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor of fossil fuel (tCO_2/TJ) that would have been used at facility '*j*' for flaring the waste gas.
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	$EF_{CO2,i}$
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor per unit of energy or mass of the fuel type *i*
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Data / parameter:	$Q_{i,h}$
Data unit:	Nm^3/h
Description:	Amount of individual fuel (waste gas and other fuel(s)) i consumed at the energy generation unit during hour h
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	**$EG_{tot,y}$**
Data unit:	TJ/year
Description:	Total annual energy produced at the power plants, with waste gas and fossil fuel.
Source of data:	Recipient plant(s) and generation plant measurement records
Measurement procedures (if any):	
Monitoring frequency:	Monthly
QA/QC procedures:	The energy meters will undergo maintenance / calibration to the industry standards. Sales records and purchase receipts are used to ensure the consistency.
Any comment:	Data shall be measured at the recipient plant(s) and at the generation plant for cross check. Sales receipts shall be used for verification. DOEs shall verify that total energy supplied by the generator is equal to total electricity received by recipient plant(s).

Data / parameter:	$Q_{WG,h}$
Data unit:	Nm^3/h
Description:	Quantity of waste gas used for energy generation per hour h
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	NCV_{WG}
Data unit:	
Description:	Net Calorific Value of Waste Gas (TJ/Nm^3)
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / parameter:	$ST_{whr,y}$
Data unit:	
Description:	Energy content of the steam generated in waste heat recovery boiler fed to turbine via common steam header
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	***$ST_{other,y}$***
Data unit:	
Description:	Energy content of the steam generated in other boilers fed to turbine via common steam header
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	***$EF_{Steam,j,y}$***
Data unit:	Tonnes CO_2 / TJ
Description:	CO_2 emission factor of the steam source that would have supplied the recipient plant j in absence of the project activity, expressed in tCO_2/TJ
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available.

Annex I: **Process for Energy Efficiency determination of baseline energy generation equipments**

The efficiency of boilers/captive plant/cogeneration plant depends significantly on the load and operational conditions.

Establish an efficiency-load-function of the boiler/captive plant/cogeneration plant, without using the oil/water emulsion technology, through on-site measurements. The fuel consumption is then determined separately for discrete time intervals *t*, based on the actual monitored heat generation/electricity generation/combined heat and electricity generation during each time interval *t* and the baseline efficiency corresponding to that heat generation/electricity generation/combined heat and electricity generation , determined with the efficiency-load-function:

$$\eta_{BL,t} = f\left(HG_{j,t}\right) + 1.96 \cdot SE(f(HG_{j,t})) \qquad \textbf{(1a-111)}$$

and

$$N_t = \frac{8760}{T} \qquad \textbf{(1a-112)}$$

where:

$FC_{BL,y}$	=	Quantity of residual fuel oil that would be fired in the boiler in the absence of the project activity in year *y* (mass or volume unit)
$HG_{j,t}/EG_{i,j,t}/EG_{j,t}+HG_{j,t}$	=	Heat generated by the boiler/Electricity generated by the captive power plant/Combined heat and electricity generated by the cogeneration plant during the time interval *t* where *t* is a discrete time interval during the year *y* (GJ)
$\eta_{BL,t}$	=	Baseline energy efficiency of the boiler/captive plant/cogeneration plant during time interval *t* where *t* is a discrete time interval during the year *y* ($\eta_{Boiler,i,j,t}/\eta_{Plant,j,t}/\eta_{Cogen,t}$)
$f(HG_{j,}t/EG_{i,j,t}/EG_{j,t}+HG_{j,t})$	=	Efficiency load function of the boiler/captive plant/cogeneration plant, determined through the regression analysis
$SE(f(HG_{j,t}/EG_{i,j,t}/EG_{j,t}+HG_{j,t}))$	=	Standard error of the result of the efficiency-load-function $f(HG_{PJ,t})$ for time interval *t* where *t* is a discrete time interval during the year *y*
t	=	Discrete time interval of duration *T* during the year *y*
N_t	=	Number of time intervals *t* during year *y*
T	=	Duration of the discrete time intervals *t* (h)

Each time interval *t* should have the same duration *T*. In choosing the duration *T*, the typical load variation of the boiler should be taken into account. The maximum value for *T* is 1 hour, resulting in 8760 discrete time intervals *t* per year y (N_t = 8760). If the load of the boiler/captive plant/cogeneration plant may vary considerably within an hour, a shorter time interval *T* should be chosen by project participants (e.g. 15 minutes).

The efficiency-load-function should be derived by applying a regression analysis to at least 10 measurements *x* within the load range where the boiler/captive plant/cogeneration plant can be operated. It is recommended that project participants apply standard software to apply the regression analysis. More details on the procedure to measure the efficiency at different loads are provided in the monitoring methodology. Each measurement *x* delivers a data pair of heat generation/electricity generation/combined heat and electricity generation ($HG_x/EG_x/HG_x+EG_x$) and efficiency of the boiler/captive plant/cogeneration plant (η_x). Project participants should choose an appropriate regression equation to apply to the measurement results. For example, in case of a polynomial function, the following regression equation would be applied:

$$\eta_x = f(HG_x) = a + b_1 HG_x + b_2 (HG_x)^2 + ... + b_n (HG_x)^n \quad \textbf{(1a-113)}$$

where:

(η_x, HG_x)	=	The pair of data recorded from measurement x at a defined load level
η_x	=	Efficiency of the boiler at measurement *x*
$HG_x/EG_x/HG_x+EG_x$	=	Quantity of heat/electricity/combined heat and electricity generated by the boiler/captive plant/cogeneration plant during the time length *T* at the measurement *x* (GJ)[12]
x	=	Measurements undertaken at defined load levels
$a, b_1, b_2, ..., b_n$	=	Parameters of the regression equation estimated using the regression analysis

In order to ensure that the results of the regression analysis are conservative, the baseline efficiency is adjusted for the upper bound of uncertainty of the result of efficiency-load-function at a 95% confidence level by introducing the standard error $SE(f(HG_{j,t}))$ in equation (1a-112) above. The standard error $SE(f(HG_{j,t}))$ has to be determined for each time interval *t*. It is recommended that project participants use the standard software to determine the standard error $SE(f(HG_{j,t}))$.

In case of a linear regression equation, i.e. if n=1 in equation (1a-114) above, the standard error can be determined as follows:

$$SE\left(f\left(HG_{j,t}\right)\right) = \sigma * \sqrt{\left(1 + \frac{1}{N_x} + \frac{(HG_{j,t} - HG)^2}{\sum_{x=1}^{N_x} (HG_x - HG)^2}\right)} \quad \textbf{(1a-114)}$$

with

$$\sigma = \frac{1}{N_x - 2} * \sqrt{(1 - R^2) * \left[\sum_{x=1}^{N_x} (\eta_x - \eta)^2\right]} \quad \text{and} \quad \textbf{(1a-115)}$$

[12] The value of $HG_x/EG_x/HG_x+EG_x$ should correspond to the quantity of heat/electricity/combined heat and electricity that would be generated in the time length T at the defined load level. If the measurement has a different duration than T, the measured quantity of heat/electricity/combined heat and electricity generation should be extrapolated to the quantity that would be generated during the time length T.

$$\eta = \frac{\sum_{x=1}^{N_x} \eta_x}{N_x} \quad \text{and} \qquad \textbf{(1a-116)}$$

$$HG = \frac{\sum_{x=1}^{N_x} HG_x}{N_x} \quad \text{and} \qquad \textbf{(1a-117)}$$

$$R = \frac{b_1^{\,2} * \sum_{x=1}^{N_x} (HG_x - HG)}{\sum_{x=1}^{N_x} (\eta_x - \eta)} \qquad \textbf{(1a-118)}$$

where:

$SE(f(HG_{j,t}/EG_{i,j,t}/EG_{j,t}+HG_{j,t}))$	=	Standard error of the result of the efficiency-load-function $f(HG_{j,t})$ for time interval *t*
$f(HG_{j,}t/EGi_{j,t}/EG_{j,t}+HG_{j,t})$	=	Efficiency load function of the boiler, determined through the regression analysis
σ	=	Standard error of the regression equation
$HG_{j,t}/EG_{i,j,t}/EG_{j,t}+HG_{j,t}$	=	Heat generated by the boiler/Electricity generated by the captive power plant/Combined heat and electricity generated by the cogeneration plant during the time interval *t* (GJ)
$HG_x/EG_x/HG_x+EG_x$	=	Quantity of heat/electricity/combined heat and electricity generated by the boiler/captive plant/cogeneration plant during the time length *T* at the measurement *x* (GJ)
HG	=	Mean heat/electricty/combined heat and electricity generation by the boiler/captive power plant/cogeneration plant during the time length *T* of all measurements *x* (GJ)
η_x	=	Efficiency of the boiler/captive plant/cogeneration plant at measurement *x*
η	=	Mean efficiency of the boiler/captive plant/cogeneration plant of all measurements *x*
R	=	Adjusted R square
x	=	Measurements undertaken at defined load levels
N_x	=	Number of measurements *x* undertaken to establish the efficiency-load-function (at least 10)
t	=	Discrete time interval of duration *T* during the year *y*
T	=	Duration of the discrete time intervals *t* (h)