

**Draft** revision to the approved baseline methodology AM0014**“Natural gas-based package cogeneration”****Source**

This methodology is based on the MGM natural gas-based package cogeneration project, Chile, whose baseline study, monitoring and verification plan and project design document were prepared by MGM International. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0018-rev: “MGM baseline methodology Natural Gas-Based Package cogeneration Project” on <http://cdm.unfccc.int/methodologies/approved>.

This methodology refers to:

- Approved consolidated methodology ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources”. Please go 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”

**Applicability**

This methodology is applicable to natural gas-based cogeneration projects under the following conditions:

- The electricity and heat requirement of the consuming facility is generated in separate systems (i.e. electricity and heat in the baseline cannot be generated in another cogeneration facility) in the absence of the project activity;
- The cogeneration system is either third party cogeneration systems, i.e. not owned or operated by the consuming facility that receives the heat and electricity from project cogeneration systems or the cogeneration system is owned by the industrial user (henceforth referred to as self-owned) that consumes the heat and electricity from project cogeneration systems;
- The cogeneration system provides all or a part of the electricity and or heat demand of the consuming facility;
- No excess electricity is supplied to the power grid and no excess heat from the cogeneration system is provided to another user;
- In the case project activity displaces electricity from fossil fuel based, dedicated power plant(s), methodology can only claim reductions from only that fraction of displaced electricity from the baseline dedicated power plant(s), for which it can be demonstrated that project activity led to reduction in generation of baseline dedicated power plant (s).

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0014 (“Natural gas-based package cogeneration”).



### Project activity

The project activity encompasses the installation of a package cogeneration system whose input is natural gas from the gas pipeline, and whose outputs are electricity and heat supplied to an industry with demand for heat and electricity. The project activity avoids consumption of a fossil fuel for heat generation and displaces electricity from the grid or fossil fuel based, dedicated power plant(s). The displaced fossil fuel power plant(s) for electricity generation may use fuels with higher carbon intensity, including fuel oil, diesel. The displaced fossil fuel for heat production, hereafter referred to as the “baseline fuel” may be natural gas or some other type of fuel with higher carbon intensity than natural gas including (but not limited to) fuel oil and coal.

### Leakage

The principal sources of “leakage” in the sense of emissions of GHG emissions outside the project boundary and attributable to the CDM project are the emission of methane from natural gas projection and pipeline leakage, associated with gas consumption of cogeneration system.

### Baseline

Baseline emissions are those emissions that those associated with the production of heat and electricity that are offset by the output of the cogeneration system. Baseline emissions comprise five components:

- a) **CO<sub>2</sub> from combustion.** CO<sub>2</sub> emissions corresponding to the combustion of a baseline fuel that would have been used if the cogeneration system did not provide **heat** to the plant.
- b) **CH<sub>4</sub> from combustion.** CH<sub>4</sub> emission corresponding to the combustion of a baseline fuel that would have been used if the cogeneration system did not provide **heat** to the plant.
- c) **N<sub>2</sub>O from combustion.** N<sub>2</sub>O emissions corresponding to the combustion of a baseline fuel that would have been used if the cogeneration system did not provide **heat** to the plant.
- d) **CH<sub>4</sub> leaks during production of the baseline fuel.** If the baseline fuel is natural gas, CH<sub>4</sub> emissions from natural gas production and leaks in the transport and distribution pipeline supplying the plant and leaks in the gas distribution piping within the plant, associated with the natural gas consumption identified in item (a) above. For other types of fuel, the baseline emissions associated with production and transportation are assumed zero for simplification and conservatism.
- e) **CO<sub>2</sub> from electricity generation.** CO<sub>2</sub> emissions associated with the electricity that would have to be purchased from the power grid or CO<sub>2</sub> emissions associated with the electricity that would have to be generated through dedicated fossil fuel power plant(s) if the cogeneration system did not provide electricity to the plant.

The baseline emissions for the first four **emission sources listed above** are proportional to the amount of baseline fuel consumption in the plant that is offset by heat supplied by the natural gas cogeneration system. Each can be represented as the product of an emissions factor and an energy consumption, which depends on the heat output of the cogeneration system.



The consumption of the fuel avoided in the baseline for the supply of heat is determined as follows:

**Annual energy consumption for heat supply at baseline plant,  $ABEC_{BF}$  (GJ/year):**

$$ABEC_{BF} = \frac{CAHO}{e_b} \quad (3.1)$$

Where CAHO = annual heat output from cogeneration system (GJ/year), and  
 $e_b$  = industrial boiler efficiency (fraction, lower heating value basis).

The annual heat output from the cogeneration system (CAHO) is estimated on the basis of the heat output rate of the cogeneration system (CHOR) and an estimate of annual operating hours (AOH) of the cogeneration system. The formula is described below:

**Annual baseline energy consumption for heat supply,  $ABEC_{BF}$  (GJ/year):**

$$ABEC_{BF} \text{ (GJ/year)} = \frac{CHOR \times AOH}{e_b} \quad (3.2)$$

Where:

CHOR = cogeneration system heat output rate (GJ/h),  
AOH = Annual operating hours (h/year), and  
 $e_b$  = boiler efficiency (fraction, lower heating value basis)

In order to be conservative, a high value of  $e_b$  is chosen. The methodology proposes a default value of 0.90

The value of **CHOR** may be determined from the specifications of the cogeneration system. A value of **AOH** should be determined from an engineering study of the proposed cogeneration system.

Once the boiler energy consumption has been quantified, the four GHG emissions components (a to d, above) can be determined, as indicated below.

**a) Baseline CO<sub>2</sub> emissions from combustion of baseline fuel for heat supply**

**Baseline CO<sub>2</sub> emissions from combustion of baseline fuel for heat supply,  $BE_{th}$  (tonnesCO<sub>2</sub>/year):**

$$BE_{th} = ABEC_{BF} \cdot EF_{BF} \quad (3.3)$$

Where:

$ABEC_{BF}$  = annual energy consumption for heat supply at baseline plant (GJ/year), and

$EF_{BF}$  = CO<sub>2</sub> emission factor of the fuel used to generate heat (t CO<sub>2</sub>/GJ)

A value of  $EF_{BF}$  needs to be estimated from the following data sources. The numbers indicate a hierarchy in data to be used, with # 1 being the best. If # 1 data are not available, # 2 data should be chosen. If these are not available, # 3 data should be chosen.

1. National GHG inventory



2. IPCC, fuel type and technology specific
3. IPCC, near fuel type and technology

**b) Baseline methane emissions from combustion of baseline fuel for heat supply to plant**

**Baseline methane emissions from combustion of baseline fuel for heat supply, BE<sub>met comb</sub> (tonne CH<sub>4</sub>/year):**

$$BE_{\text{met comb}} (\text{tonne CH}_4/\text{year}) = \frac{ABEC_{BF} \times MEF}{10^6} \quad (3.4)$$

Where

ABEC<sub>BF</sub> = annual baseline energy consumption for heat supply (GJ/year), and

MEF = methane emission factor for baseline fuel combustion (kg CH<sub>4</sub>/TJ), lower heating value basis)

**In units of carbon dioxide equivalent, BE equity met comb (tonne CO<sub>2</sub> eq/year)**

$$BE_{\text{equiv met comb}} (\text{tonne CO}_2 \text{ equiv / year}) = BE_{\text{met comb}} \times GWP (\text{CH}_4) \quad (3.5)$$

Where GWP (CH<sub>4</sub>) = global warming potential of methane = 21

The value of **MEF** needs to be estimated from the following data sources. The numbers indicate a hierarchy in data to be used with # 1 being the best. If # 1 data are not available, #2 data should be chosen.

1. IPCC, fuel type and technology specific
2. IPCC, near fuel type and technology

**c) Baseline nitrous oxide emissions from combustion of baseline fuel for heat supply to plant**

**Baseline nitrous oxide emissions from combustion of baseline fuel for heat supply, BE<sub>N<sub>2</sub>O comb</sub> (tonne N<sub>2</sub>O/year):**

$$BE_{N_2O \text{ comb}} (\text{tonne CH}_4/\text{year}) = \frac{ABEC_{BF} \cdot NEF}{10^6} \quad (3.6)$$

Where

ABEC<sub>BF</sub> = annual baseline energy consumption for heat supply (GJ/year), and

NEF = nitrous emission factor for fuel combustion (kg N<sub>2</sub>O/TJ), lower heating value basis)

**In units of carbon dioxide equivalent, BE equity met comb (tonne CO<sub>2</sub> eq/year)**

$$BE_{\text{equiv N}_2\text{O comb}} (\text{tonne CO}_2 \text{ equiv / year}) = BE_{N_2O \text{ comb}} \times WP (\text{CH}_4) \quad (3.7)$$

GWP (N<sub>2</sub>O) = global warming potential of nitrous oxide = 310

The value of NEF needs to be estimated the following data sources. The numbers indicate a hierarchy in data to be used, with # 1 being the best. If # 1 data are not available, # 2 data should be chosen.



1. IPCC, fuel type and technology specific
2. IPCC, near fuel type and technology

**d) Baseline methane emissions from natural gas production and pipeline leaks in the transport and distribution**

This section is applicable only for projects that displace natural gas in the baseline for heat generation. For baseline fuel other than natural gas,  $BE_{th\ fug}$  is assumed zero for simplification and to be chosen.

The value of MLR needs to be estimated from the following data sources. The numbers indicate a hierarchy in data to be used, with # 1 being the best. If # 1 data are not available, # 2 data should be chosen.

1. National estimates (if available)
2. IPCC estimates of fugitive emissions from oil and natural gas activities.

**Baseline methane emissions from natural gas production and leakage in transport and distribution, corresponding to heat supply,  $BE_{th\ fug}$  tonne  $CH_4$ /year):**

$$BE_{th\ fug} \text{ (tonne } CH_4 \text{/year)} = \frac{ABEC_{BF}}{10^3} \times MEF \quad (3.8)$$

Where

MLR = Methane Leakage Rate in natural gas production, transport and distribution leakage, including leaks at the industrial site (kg  $CH_4$ /GJ natural gas energy consumption, lower heating value basis).

$ABEC_{NG}$  = annual baseline natural gas energy consumption for heat supply (GJ/year)

**In units of carbon dioxide equivalent,  $BE_{th\ equiv\ fug}$  (tonne  $CO_2$  equiv/year):**

$$BE_{th\ equiv\ fug} \text{ (tonne } CO_2 \text{ - equiv / year)} = BE_{th\ fug} \text{ GWP (} CH_4 \text{)} \quad (3.9)$$

Where  $GWP(CH_4)$  = is defined as before = 21

**e) Baseline emissions of  $CO_2$  from electricity supply to industrial plant that is offset by electricity supplied from cogeneration system**

The final item of GHG emissions in the baseline arises from electricity, corresponding to the emissions avoided at the power plants supplying the public grid /  $CO_2$  emissions associated with the electricity that would have to be generated through dedicated fossil fuel power plant(s) system. The relevant formulae are described below:

**1. Electricity Displaced from Public System:**

**Baseline carbon dioxide emissions for electricity supplied,  $BE_{elec\ grid}$  (tonne  $CO_2$ /year):**

$$BE_{elec\ grid} \text{ (tonne } CO_2 \text{/year)} = \frac{CEO \cdot BE_{elec\ grid}}{10^3} \quad (3.10)$$

Where

$CEO$  = cogeneration electricity output (MWh/year), and



$BEF_{elec\ grid}$  = baseline CO<sub>2</sub> emissions factor for electricity from public supply (kg CO<sub>2</sub>/MWh)

**OR**

**2. Electricity displaced, that would have to be generated through dedicated fossil fuel power plant(s) system:**

**Baseline carbon dioxide emissions for electricity supplied,  $BE_{elec\ fossil\ fuel}$  (tonne CO<sub>2</sub>/year):**

$$BE_{elec\ fossil\ fuel} \text{ (tonne CO}_2\text{/year)} = \frac{CEO \cdot BEF_{elec\ fossil\ fuel}}{10^3} \quad (3.11)$$

Where

$CEO$  = Cogeneration Electricity Output (MWh/year), and

$BEF_{elec\ fossil\ fuel}$  = Baseline CO<sub>2</sub> emissions factor for electricity from the dedicated fossil fuel power plant(s) system (kg CO<sub>2</sub>/MWh)

$$BEF_{elec\ fossil\ fuel} = \frac{\sum (PG_{i,n} * SEF_{i,n})}{\sum PG_{i,n}}$$

$PG_{i,n}$  = Power generated by sources i (in MWh-unit), by relevant power sources n, sources delivering electricity to the manufacturing plant consuming facility

$SEF_{i,n}$  = Specific CO<sub>2</sub> emissions factor Fuel consumption of the fossil fuel power generation sources n (in terms of kgms/ MWh), sources delivering electricity to the manufacturing plant consuming facility

$n$  = Number of fossil fuel power generation sources

The actual baseline emissions are determined by monitoring cogeneration electricity output ( $CEO$ ) and calculating  $BE_{elec}$ . For an *a priori* estimation of the baseline CO<sub>2</sub> emissions for electricity supply to the plant,  $CEO$  is determined by the cogeneration electric power output ( $CPO$ ) and annual operating hours ( $AOH$ ), in a manner similar to Eq. (3.2) for heat output, and is described below.

**Annual electricity generation from the cogeneration system,  $CEO$  (MWh/year):**

$$CEO \text{ (MWh / year)} = \frac{CEO \times AOH}{10^3} \quad (3.11)$$

Where  $CEO$  = cogeneration system net power output capacity (MWe), and

$AOH$  = annual operating hours of cogeneration system (h/year)

To estimate  $BEF_{elec}$ , the CO<sub>2</sub> emission factor for electricity supply, users of this methodology shall refer to the “Consolidated Baseline Methodology for Zero-emissions Grid-Connected Electricity Generation from Renewable Sources” where different ways of determining CO<sub>2</sub> emission factors for electricity supply from the grid are provided, or to the “Simplified Methodology for Small-scale CDM Project activities” (in case electricity displaced is less than or equal to 15 MW equivalent).



**Total baseline emissions** are given by the sum of the components analyzed above:

$$BE_{\text{total}} = BE_{\text{th}} + BE_{\text{equiv met comb}} + BE_{\text{equiv N2O comb}} + BE_{\text{th equiv fug}} + BE_{\text{elec}} \text{ grid / fossil fuel} \quad (3.15)$$

### Emission Reductions

Emission reductions are calculated as the difference between baseline and project emissions, taking into account any adjustments for leakage: Project emissions are those associated with natural gas consumption by the cogeneration system, including CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions from natural gas combustion and CH<sub>4</sub> emissions from natural gas production and pipeline leakage, associated with the gas consumption of the cogeneration system.

### Additionality

First likely alternative baseline scenarios are described:

1. Industrial plant continues to operate with equipment replacement as needed with no change in equipment efficiency (The frozen-efficiency scenario).
2. Industrial plant continues to operate with improved efficiency new equipment at the time of equipment replacement using a less carbon intensive fuel.
3. Industrial plant upgrades the thermal energy generating equipment and therefore increases the efficiency of boiler(s) immediately.
4. The heat and or electricity demand of the industrial plant is reduced through improvements in end-use efficiency.
5. Installation of a cogeneration system owned by the industrial plant.
6. Installation of a package cogeneration system owned by a company other than the industrial plant (The proposed project).
7. Installation of a cogeneration system by a third party.

The project developer can demonstrate additionality by selecting one of the following two options:

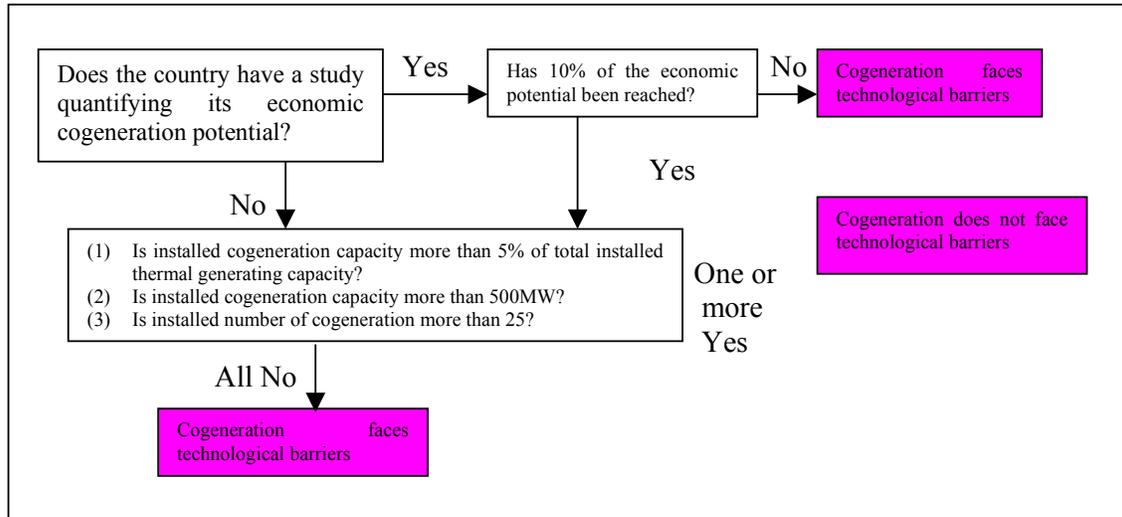
- Option 1: apply Step 2 of the latest version of the “Tool for demonstration and assessment of additionality” (Investment Analysis).
- Option 2: Methodology-specific process for determination of additionality as follows:

Four additionality tests are applied. The first two tests are applicable to any cogeneration ownership scenario. The third test is specific to the “package cogeneration” case where the cogeneration system is owned by a party other than the industry using the heat and electricity from the system. The fourth test is specific to the “package cogeneration” case for the self-owned cogeneration system. In the case of self owned Cogeneration project activities the project activity is additional if all the four additionality tests result in project being assessed as additional, whereas, only the first three tests need be applied in the case of third party ownership

1. Are there technological barriers to cogeneration in the country?



Additionality test 1 is applied by following the flow chart below. A low market share of cogeneration means that there is insufficient infrastructure to support installation and maintenance of such systems, acting as a technological barrier to project participants.



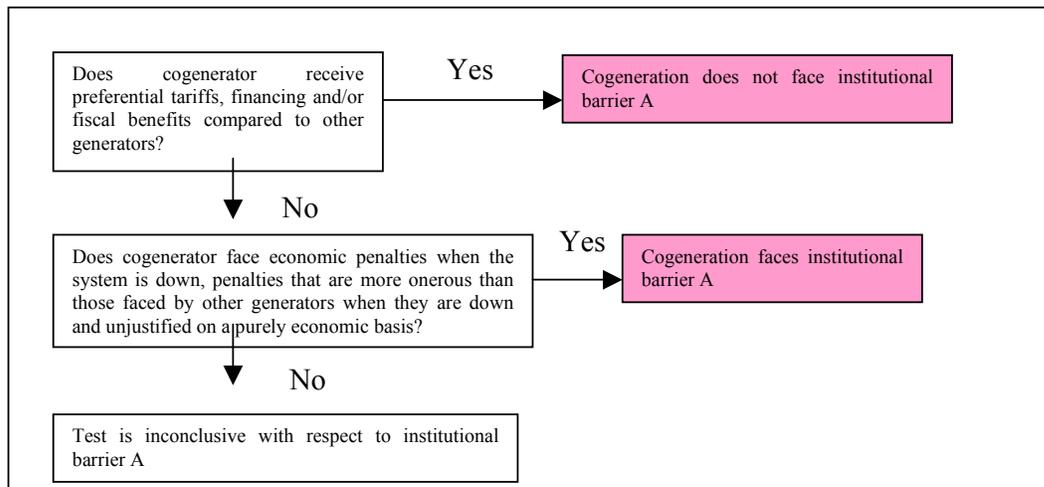


2. A. Institutional barrier: Are there institutional barriers to cogeneration in general?

Additionality test 2A is applied by following the flow chart below. It should be noted that even if preferential tariffs or other incentives do exist, they may not be sufficient to promote cogeneration.

A serious barrier may be present, especially in deregulated power systems. All electricity users may have to pay the maximum demand charge for the whole year. Thus, when the cogeneration system is not operating (due to routine maintenance or forced outage), the user of electricity would have to purchase the electricity from the power grid. While this period may be small, the purchase may involve paying for the power demand (dW) for the whole year. This is a significant penalty for users of cogeneration systems.

If institutional barriers are not present, but there are no specific incentives to cogeneration, then the test indicated is inconclusive with respect to institutional barrier A. Other barriers (such as technological barrier or institutional barrier B) will need to be considered to determine additionality.

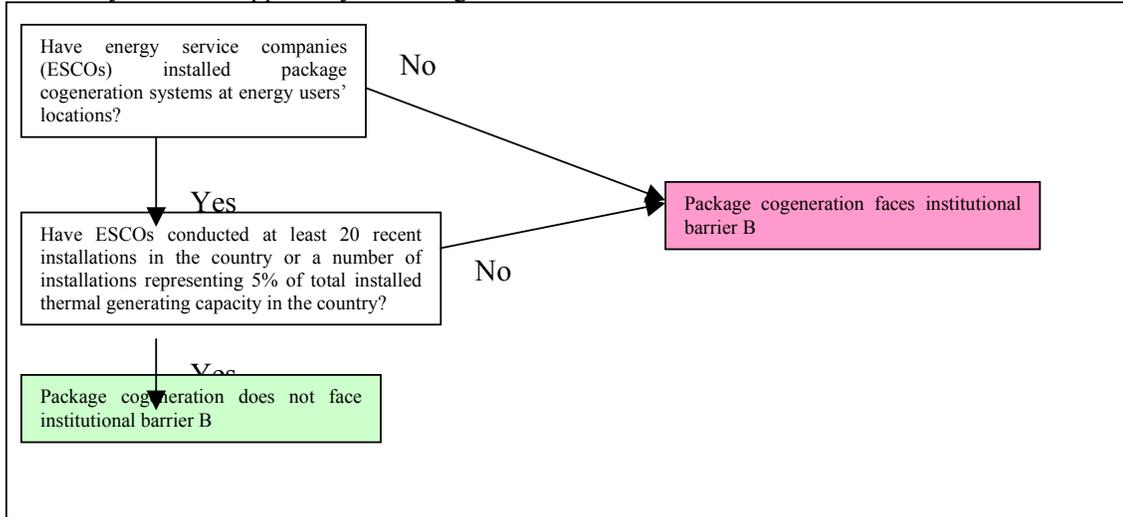


2B. Institutional barrier for ESCOs: Are there institutional barriers to the “package cogeneration” operational context? In other words, is there enough experience in which one company installs a cogeneration system at the location of a separate energy user?

The traditional practice is for an industrial user to meet their electricity and natural gas demand by purchases from power and gas companies respectively. In a packaged cogeneration system, the institutional arrangement is very different. In this case, the project developer invests in and installs the cogeneration system at the industrial user site, and provides electricity and heat to that user. This institutional arrangement requires project developer to have special management resources and organizational capacity, and for the industrial energy user to accept this arrangement. Where such experience is lacking, promoting the new arrangement involves a significant institutional barrier.



Additionality test 2B is applied by following the flow chart below:

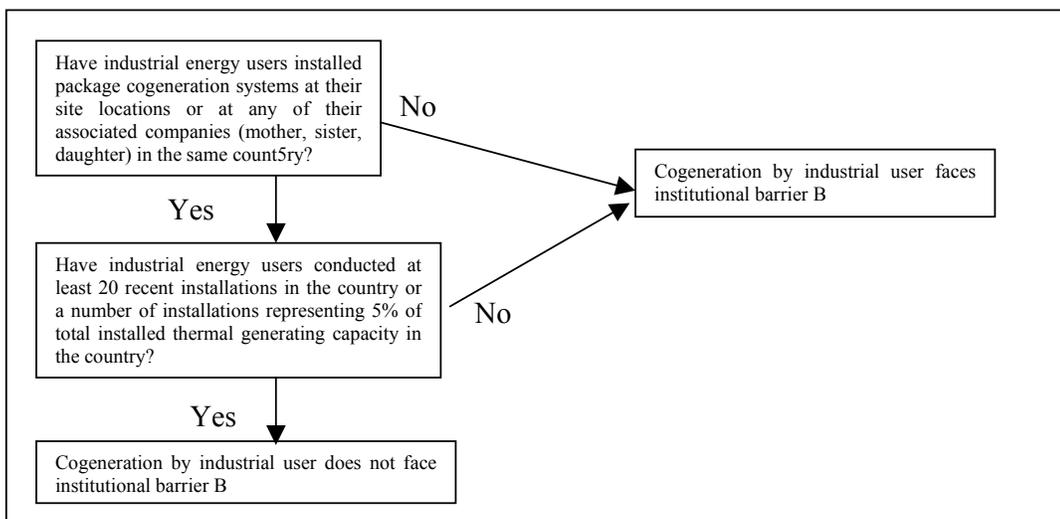


2C. Institutional barriers for Industrial Users:

Are there institutional barriers to the ‘Package cogeneration’ operational context? In other words is there enough experience in which an industrial user can install and operate a cogeneration system at it’s plant premises?

The traditional practice is for an industrial user to meet their electricity and natural gas demand by purchases from power and gas plants respectively. In this case, the industrial user installs and operates the cogeneration system for use at its own site. This arrangement requires the industrial user to have specific expertise and knowledge of cogeneration systems. Where such experience is lacking, promoting the new arrangement involves a significant institutional barrier.

Additionality test 2C is applied by the following flow chart below:



If the above additionality tests determine that a package cogeneration system is additional with respect to scenarios where no cogeneration system, scenarios 1 to 4 remain as baseline options. The selection cannot be made without a substantial analysis. Therefore, a conservative approach is taken



by assuming a high value for  $e_b$  in Eq. 3.2 to calculate the baseline emissions. This assumption implies reduced natural gas consumption in the baseline, and therefore reduced emission reductions compared to option 1-3. Option 4 is discounted for by determining the baseline ex-post on the basis of actual heat and electricity of the industrial plant.

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**Applicability**

This methodology is applicable to natural gas-based cogeneration projects under the following conditions:

- The baseline comprises different sources for both electricity and heat for the consuming facility (i.e. electricity and heat in the baseline cannot be generated in another cogeneration facility).
- The cogeneration system is a third party cogeneration systems, i.e. not own or operated by the consuming facility that receives the project heat and electricity or the cogeneration system is owned by the industrial user (henceforth referred to as self-owned) that consumes the project heat and electricity;
- The cogeneration system provides all or a part of the electricity and or heat demand of the consuming facility;
- No excess electricity is supplied to the power grid and no excess heat from the cogeneration system is provided to another user;
- In the case project activity displaces electricity from fossil fuel based, dedicated power plant(s), methodology can only be used as long as displaced electricity from the captive power plant(s) will not be used by other users during the crediting period of the project activity in question.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0014 (“Natural gas-based package cogeneration”).

**Monitoring Methodology**

The monitoring methodology involves monitoring of the following:

- The natural gas consumption at the cogeneration system;
- Heat production at the cogeneration system;
- Electricity production at the cogeneration system;
- Fate of the electricity displaced by the project activity, in the case project activity displaces electricity from fossil fuel based, dedicated power plant(s).



Project emissions correspond to natural gas combustion by the cogeneration system, and includes the same four components as in the baseline (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions from combustion) and CH<sub>4</sub> emissions from natural gas production and leaks in the transport and distribution pipeline supplying the plant and leaks in the gas distribution piping within the plant, associated with the natural gas consumption. Each of these is proportional to the natural gas consumption in the cogeneration system, which is monitored. Emissions are then calculated as follows:

**a) CO<sub>2</sub> emissions from natural gas combustion in cogeneration system**

**Carbon dioxide emissions from natural gas combustion in the cogeneration system, E<sub>cs</sub> (tonnesCO<sub>2</sub>/year):**

$$E_{cs} = \text{tonne CO}_2 / \text{year} \frac{AEC_{NG} \cdot EF_{NG}}{10^3} \quad (4.1)$$

Where  $AEC_{NG}$  = annual energy consumption of natural gas in cogeneration system (GJ/year), and

$EF_{NG}$  = CO<sub>2</sub> emission factor of natural gas (kg CO<sub>2</sub>/GJ, lower heating value basis)

**b) Methane emissions from natural gas combustion in cogeneration system**

A certain amount of methane is generated in the combustion of natural gas. These are generally expressed in terms of natural gas energy consumption. Emissions are estimated using formulae described below:

**Methane emissions from natural gas combustion in the cogeneration system, E<sub>met comb</sub>**

$$E_{\text{met comb}} = \text{tonne CO}_2 / \text{year} \frac{AEC_{NG} \cdot MEF}{10^3} \quad (4.2)$$

Where  $AEC_{NG}$  = annual energy consumption of natural gas in cogeneration system (GJ/year), and

$MEF$  = methane emission factor for natural gas combustion  
(kg CH<sub>4</sub>/TJ, lower heating value basis)

**In units of carbon dioxide equivalent emission, E<sub>equiv met comb</sub> (tonne CO<sub>2</sub> equiv/year)**

$$E_{\text{equiv met comb}} (\text{tonne CO}_2 - \text{equiv} / \text{year}) = E_{\text{met comb}} \text{GWP} (\text{CH}_4) \quad (4.3)$$

Where  $\text{GWP} (\text{CH}_4)$  = global warming potential of methane = 21

**c) Nitrous oxide emissions from natural gas combustion in cogeneration system**

A certain amount of nitrous oxide is generated in the combustion of natural gas. These are generally expressed in terms of natural gas energy consumption. Emissions are estimated using formulae similar to those for methane emissions in combustion, and are described below:

**Nitrous oxide emissions from natural gas combustion in the cogeneration system,** $E_{N_2O\ comb}$  (tonne  $N_2O$  / year), are given by:

$$E_{N_2O\ comb} \text{ (tonne } CH_4 \text{ / year)} = \frac{AEC_{NG} NEF}{10^3} \quad (4.4)$$

Where  $AEC_{NG}$  = annual energy consumption of natural gas in the cogeneration system (GJ/Year),  
and

$NEF$  = nitrous oxide emission factor for natural gas combustion

(kg  $N_2O$ /TJ, lower heating value basis)

**In units of carbon dioxide equivalent emission,  $E_{equiv\ N_2O\ comb}$  (tonne  $CO_2$  equiv/year)**

$$E_{equiv\ N_2O\ comb} \text{ (tonne } CO_2 \text{ – equiv / year)} = E_{N_2O\ comb} GWP (N_2O) \quad (4.5)$$

Where  $GWP (N_2O)$  = global warming potential of nitrous oxide = 310

**d) Methane emissions from natural gas production and pipeline leaks in the transport and distribution of natural gas, including leakage within the industrial plant**

These baseline emissions are associated with natural gas consumption in the cogeneration system.  
The procedure for estimating these emissions is described below:

**Methane emissions from natural gas production and leakage in transport and distribution, corresponding to fuel used in cogeneration system,  $E_{fug}$  (tonne  $CH_4$  / years), are given by:**

$$E_{fug} \text{ (tonne } CH_4 \text{ / year)} = \frac{AEC_{NG} MLR}{10^3} \quad (4.6)$$

Where  $AEC_{NG}$  = is defined as before, and

$MLR$  = methane leakage rate in natural gas production, transport and distribution leakage,  
including leaks at the industrial site (kg  $CH_4$ /GJ natural gas energy consumption, lower  
heating value basis)

**Convert methane emissions to carbon dioxide equivalent emissions,  $E_{equiv\ fug}$  (tonne  $CO_2$  equiv / year)**

$$E_{equiv\ fug} \text{ (tonne } CO_2 \text{ – equiv / year)} = E_{fug} GWP (CH_4) \quad (4.7)$$

Where  $GWP (CH_4)$  = is defined as before = 21.

**Total project emissions are given by the sum of the components analyzed above:**

$$E_{total} = E_{CS} + E_{equiv\ met\ comb} + E_{equiv\ N_2O\ comb} + E_{equiv\ fug} \quad (4.8)$$

The equations used to estimate project emissions are structurally very similar to those used in order to determine baseline emission. Project emissions are determined from natural gas consumption by the cogeneration. Baseline emissions depend on heat and electricity output from the cogeneration system that is supplied to the industrial plant, and are determined in a dynamic manner from monitored data using Equations leading up to Eq. 3.15. By considering



**baseline and project emissions, emissions reductions are determined in a straight forward manner.**

*Parameters to be monitored*

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
1	Volume of natural gas consumed	MEC <sub>NG</sub>	m <sup>3</sup>	m	Monthly	100%	Paper (field record) electronic (spreadsheet)	Paper: 1 year, Electronic: 7 years	
2	Cogeneration electricity supplied to industrial plant	MCEO	MWh	m	Monthly	100%	Electronic (spreadsheet)	Electronic: 7 years	
3	Cogeneration heat supplied to industrial plant	MCHO	GJ	m	Monthly	100%	Electronic (spreadsheet)	Paper: 1 year Electronic: 7 years	
4	Electricity generated by dedicated power plants(s)	Level of utilization of the baseline dedicated power plant(s)	MWh	m	annual	100%	Paper (field record) electronic (spreadsheet)	Paper: 1 year Electronic: 7 years	Please see note 1 below this table.



Note 1: During each verification a report has to be produced, showing that electricity produced by the baseline dedicated power plant(s) have been reduced by at least the same amount as the electricity generated by the project activity cogeneration plant. If not, the credits for electricity generation has to be reduced by equivalent of excess electricity produced by the baseline dedicated power plant(s). This shall be estimated using the historic generation of the baseline dedicated power plant(s) and electricity production of the dedicated power plant(s) during the crediting period, if operational. This is applicable to cases where the baseline dedicated power plant(s) are not scrapped and continue to operate along with the project activity cogeneration plant.

**Quality Control (QC) and Quality Assurance (QA) Procedures**

<b>Data</b>	<b>Uncertainly level of data (High/Medium/Low)</b>	<b>Are QA/QC procedures planned for these data?</b>	<b>Outline explanation why QA/QC procedures are or are not being planned</b>
1	Low	Yes	These data will be used as supporting information to calculate emission reductions by project activity
2	Low	Yes	These data will be used as supporting information to calculate emission reductions by project activity
3	Low	Yes	These data will be used as supporting information to calculate emission reductions by project activity
4	Low	Yes	These data will be used as supporting information to calculate emission reductions by project activity