Draft baseline and monitoring methodology AM00XX

Installation of Cogeneration system supplying electricity & chilled water to new and existing consumers

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the following proposed new methodology:

- NM0288 "Installation of Combined Cooling Heating and Power (CCHP) systems in commercial buildings of DLF Building - 10, Gurgaon, India" prepared by DLF Utilities Private Limited.

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

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

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

Selected approach from paragraph 48 of CDM modalities and procedures

"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:

Absorption Chiller. An absorption chiller produces chilled water and is driven by a heat source. Compared to electrical vapour compression chillers this heat is usually delivered to the chiller by steam, hot water, or direct combustion. Chilled water produced by the absorption chillers is used for air conditioning/or any other cooling applications of the consumers.

Consumers. One or more industrial/commercial/institutional buildings that are supplied with electricity and/or chilled water from the project activity. These include ***new consumers*** which are sites where no electricity and/or chilled water were consumed prior to the implementation of the project activity. ***Existing consumers*** are sites that used electricity and chilled water prior to the implementation of the project activity. Clusters of small residential or commercial consumers can be considered as a single project consumer**.** Examples of consumers are: commercial buildings or facilities, hospitals, universities, public buildings or institutions, residential buildings complexes etc.

Cogeneration. Defined for the purpose of this methodology as the simultaneous production of electricity and chilled water from a single heat source using fossil fuel.

Power consumption function. The function which provides the correlation between specific electricity consumption of an electrical vapour compression chiller and the chiller output, the inlet temperature of the condensing water and the outlet temperature of the chilled water. This function can be presented as a mathematical function or as a table.

Reference Power Plant or reference electrical vapour compression chiller. Commonly installed new power plant or electrical vapour compression chiller in the respective industry sector in the country or region. The reference power plant/chiller has to be identified for the purpose of its comparison with project power plant/chiller implemented under the project activity. The identification of the reference plant should exclude plants implemented as CDM project activities. In cases where no such plant exists in the country, the reference plant/chiller (and its efficiency) should be identified through economic analysis to identify the most probable situation in the baseline for generating the same amount of electricity or cooling capacity.

Applicability

(1) This methodology applies to the installation of a new cogeneration plant simultaneously producing chilled water and generating electricity.[1] In addition to the cogeneration plant, the project activity supplies electricity and chilled water to the following:

   (a) A new consuming facility, where in absence of the CDM project activity chilled water is most likely to be produced by electrical vapour compression chillers and/or electricity is supplied by the grid and/or generated and supplied by on-site or off-site captive power plants and/or;
   (b) An existing consuming facility, where chilled water is currently produced by electrical vapour compression chillers and/or electricity is supplied by the grid and/or generated and supplied by on-site or off-site captive power plants.

(2) For existing consumers, chilled water produced by the cogeneration system is used on-site to meet all or part of the consumers' demand. Existing electrical vapour compression chillers may remain in operation after the implementation of the project activity to supply the balance of the demand or provide backup, if the cogeneration system has insufficient capacity to supply the total chilled water demand of the consumers. However, the emission reductions should only be claimed for the chilled water produced by the new absorption chillers.

(3) After the implementation of the project activity, the old chillers and captive power plants installed prior to the project activity should only be used for back-up purposes and to supply the balance of demand of electricity and chilled water of the consumer, i.e. the amount of services that the cogeneration cannot supply. If the electricity and chilled water demand at a consumer facility increase above historical levels, for a cumulative period longer than 3 months during the crediting period (up to 10% above the maximum observed in a 3 years period prior to the project activity), and this increased demand is supplied by the project cogeneration system and the remaining (old) equipment, the emission reductions generated from producing chilled water and electricity for this particular consumer must be excluded up to the end of the crediting period.[2]

(4) If heat from the cogeneration plant is utilised for purposes other than cooling, for example, if hot water is produced, the emissions from the cogeneration facility associated with the generation of this hot water should be counted towards the project activity emissions. Project activity can not claim any emission reduction for the generation of these products (e.g. hot water). The income/energy savings generated from these products (e.g. hot water), have to be accounted for in the additionality assessment.

[1] If heat from the cogeneration process is not available, the absorption chillers may use direct fuel firing to produce chilled water. The emissions from the direct firing are accounted for in the emission calculations.

[2] In case that project participants wish to expand this methodology to potential capacity expansion projects, a request for revision must be submitted including provisions concerning baseline selection and additionality assessment.

(5) The electricity produced by the cogeneration system is used to supply all or part of the consumers' electricity demand. After the implementation of the project activity, the consumers may remain connected to the electricity grid/captive power generating units/back-up power plants (e.g. DG sets), which are used to supply the balance of electricity demand if the cogeneration system has insufficient capacity to supply the total electricity demand of the consumers. The electricity generation of the backup power generating units is capped to ensure that these units are not used to increase capacity after implementation of the project activity. The cap is 5% of the total electricity generation capacity of the cogeneration facility. On a yearly basis, the electricity generated from the backup generating units cannot be more than 5% of the electricity generated by the project activity.

(6) After the implementation of the project activity, the cogeneration facility cannot supply services to facilities that are outside the project boundary.

(7) All the consumers in the project boundary (existing and new) are clearly identified in the CDM-PDD. Consumers cannot be added to the project after the project registration for CDM.

(8) Consumers can use one or both of the services provided by the project activity, i.e. a consumer can use electricity or chilled water or both.

(9) In addition, the applicability conditions of the tools referred to above, are included.

II. BASELINE METHODOLOGY PROCEDURE

Project Boundary

The project boundary encompasses the physical, geographical site where the cogeneration system is installed. The boundary includes the facilities consuming electricity and chilled water produced by the cogeneration system and the equipments that are affected by the project activity.

The baseline emissions sources include:

(a) GHG from fossil fuel for power generation (i.e. power from the grid or captive power supply to all consumers);
(b) GHG from fossil fuel for chilled water production (i.e. electricity used by vapour compression chillers from grid/captive power plants) for each consumers.

The project activity gases and sources include:

(a) GHG from fossil fuels used to generate power in the cogeneration system;

(b) GHG from fossil fuels used to produce chilled water, for example, auxiliary firing in the absorption chillers or in case the waste flue gases are not available from the cogeneration system;
(c) GHG from electricity consumption in the auxiliary systems of the cogeneration plant.

Figure 1 below illustrates the spatial extent of the project boundary.

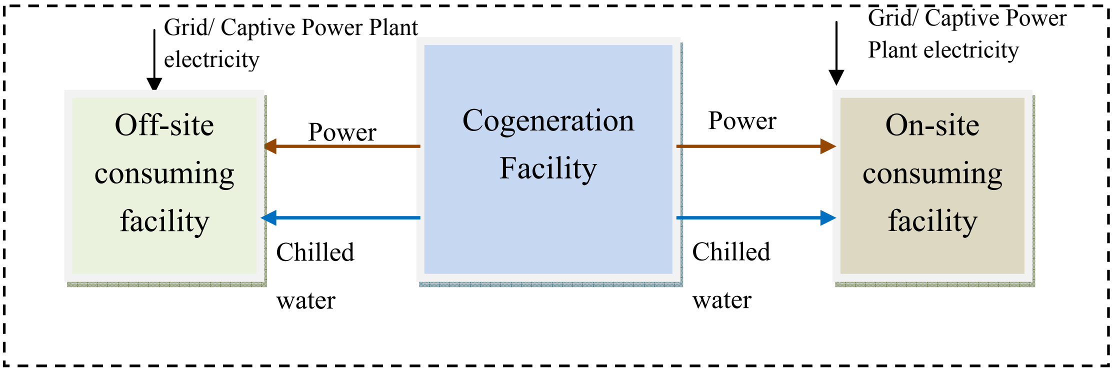

Figure 1: Project boundary

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

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

Source		Gas	Included?	Justification / Explanation
Baseline	GHG emissions from electricity imported from the grid and/or captive power plants to all consumers	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Baseline emissions from chillers must be included.	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project activity	GHG emissions from combustion of fossil fuels in the cogeneration facility	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	GHG emissions from the grid supplying power during startup or shut down of the cogeneration facility and/or to meet the balance of demand which is not supplied by cogeneration plant	CO2	Yes	Main emission source
		CH4	No	Excluded for simplification
		N2O	No	Excluded for simplification

Source		**Gas**	**Included?**	**Justification / Explanation**
	GHG emissions from the stand-by captive power plant to supply power facilities during startup or shutdown of the cogeneration plant and/or to meet the balance demand which is not supplied by cogeneration plant.	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

Procedure for estimating the end of the remaining lifetime of existing chillers

The crediting period cannot exceed the estimated remaining lifetime of the existing on-site electrical vapour compression chiller and/or captive power plant at the consumer site or at the existing cogeneration site that are replaced by the project activity. The point in time at which the chiller/ captive power plant has to be replaced should be estimated in a conservative manner, using the latest version of the "Tool to determine the remaining lifetime of equipment".

Procedure for the identification of the most plausible baseline scenario and assessment of additionality

Project proponents shall determine the most plausible baseline scenario through the application of the steps prescribed by the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality".

Step 1: Identification of alternative scenarios

The following should be considered for each consumer:

- Alternatives for meeting **electricity demand** in the absence of the CDM project activity;
- Alternatives for meeting the **chilled water demand** in the absence of the project activity.

Project participants should assess the alternative baseline scenarios for each consumer. For existing consumers, historical data for the electricity and chilled water consumption should be considered. In the absence of historical data, the energy consumption design data may be considered in presenting the baseline. Scenarios that could be considered are given in Table 2.

Table 2: Alternative electricity supply scenarios available to consumers

Alternatives for electricity supply to existing and new consumers on and off site	**Existing consumers**	**New consumers**
P1 Consumer installs a cogeneration facility	The consumer installs a cogeneration facility to provide electricity to itself	The consumer installs a cogeneration facility to provide electricity to itself

P2 Electricity supply from grid	The existing consumer continues to purchase electricity from the grid	New consumers start purchase electricity from the grid (includes the electricity needed to run the chillers)
P3 Electricity generation in a fossil fuel fired captive power plant	Existing project consumers continue to operate installed captive power plants	New consumers implement captive power plants to meet the electricity demand
P4 Electricity supply from renewable power plant	Existing project consumers switch to renewable power plants to meet the electricity demand	New project consumers implement renewable energy power plants to meet the electricity demand
P5 The project implemented not as CDM	P5 The project implemented not as CDM	P5 The project implemented not as CDM

For meeting chilled water demand of the consumers, alternative(s) may include, inter alia:

Table 3: Alternative chilled water supply options to consumers

Alternative for chilled water supply to existing and new consumers on and off site	**Existing consumers**	**New consumers**
C1 Consumer installs a cogeneration facility	Existing consumer/s installs a cogeneration facility to supply their own chilled water to meet their demand	New consumer/s installs a cogeneration facility to supply their own chilled water to meet their demand
C2 Installation of electrical vapour compression chillers	Existing consumer continues using electrical vapour compression chillers to meet the chilled water demand	New consumers install electrical vapour compression chillers
C3 Chilled water generation in fossil fuel fired absorption chillers	Existing consumers continue to operate fossil fuel fired absorption chillers to supply chilled water demand	New consumers install fossil fuel fired absorption chillers

C4 Chilled water generation in renewable energy based absorption chillers	Existing consumers continue to operate renewable energy based absorption chillers to supply chilled water demand	New consumers install renewable energy based absorption chillers
C5 The project implemented not as CDM	C5 The project implemented not as CDM	C5 The project implemented not as CDM

Table 4: Alternative options to the Project Developer

Alternatives for project developer	**Description**
D1 Project proponents do not take up any investment	Continuation of current practice i.e. consumers use the electricity from grid or existing power plants and use electrical vapour compression chillers
D2 Installation of a cogeneration facility by project developer, fuelled by biomass	Project developers install a biomass-fired cogeneration facility
D3 Installation of a cogeneration facility by project developer, not as CDM	The project developer invests in the implementation of a cogeneration facility to supply chilled water to consumers and the project is not undertaken as a CDM project

Subsequently, all credible **combinations** of baseline scenarios for power and chilled water production should be identified and documented in the CDM-PDD.

The methodology is applicable if the baseline scenario is identified to be the following:
For new consumers, P2 and/or P3 represent the case for electricity and C2 represents the case for chilled water and D1 represents the case for the project proponents of cogeneration facility.

The project activity involves the installation of a new cogeneration plant:

- At a site where no electricity and/or chilled water was generated prior to the implementation of the project activity;
- In the absence of the project activity the electricity demand for consumers would be met through grid electricity and/or captive power;
- In the absence of the project activity the chilled water demand of consumers is met through electrical vapour compression chillers.

In the case of existing consumers, the project activity involves the installation of a new cogeneration plant to supply sites that have utilised electricity and chilled water prior to the implementation of the project activity. In the absence of the project activity the electricity demand is met through grid electricity and/or captive power plants. In the absence of the project activity the chilled water demand is met through electrical vapour compression chillers.

Reference Plant Description

In cases where realistic and credible alternative(s) include the installation of a **new** captive power generation facility and/or a new electrical vapour compression chiller at the consumer's site (*reference plant*) the technology choice should be based on the common practise for new captive power plants (and fuel types) or electrical vapour compression chillers in the respective industry sector in the country or region and should be identified among those which provide the same service (i.e. the same power and/or cooling quantity). The identification of the reference plant should exclude plants implemented as CDM project activities. In cases where no such plant exists within the country, the economically most attractive technology and fuel type[3] should be identified among those which provide the same service (i.e. the same power and/or cooling capacity), that are technologically available and that are in compliance with relevant regulations. The efficiency of the technology should be selected in a conservative manner, i.e. where several technologies could be used and are similarly economically attractive, the most efficient technology should be considered.

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

Guidance for investment analysis

The investment analysis shall be based on the levelized cost of provided services (electricity, and chilled water produced at the cogeneration facility), and shall explicitly state the following parameters;

- Investment requirements (including break-up into major equipment costs, required construction work, and installation);
- A discount rate appropriate to the country and sector (use government bond rates, increased by a suitable risk premium to reflect private investment in cogeneration projects, as substantiated by an independent (financial) expert);
- Efficiency of equipment, taking into account any differences between fuels;
- Operating costs for each fuel (especially, handling/treatment costs for coal);
- Other operation and maintenance cost;
- For additionality purposes, any income generated from the sale of hot water, heat generated from the cogeneration facility used for heat purposes, electricity and chilled water, should be accounted for in the investment analysis.

Additionality of the project should be demonstrated using the "Combined tool to identify the baseline scenario and demonstrate additionality"

When investment analysis is used, the indicator used for comparing the alternatives shall be the price of power and/or the price of chilled water delivered on the consuming facility.

For other barriers, the "Guidelines for objective demonstration and assessment should be followed.

Baseline Emissions

Project emissions should account for all emissions due to the production of electricity and chilled water to supply the consumers in the project scenario. Baseline emissions account for all emissions that would result from the production of electricity chilled water to supply the consumer sites in the absence of the project activity and are capped accordingly as defined in the corresponding sections below.

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[3] Fuel type is relevant only for the power plant. The chiller uses electricity.

The total baseline emissions are calculated as follows:

$$BE_y = BE_{EL,y} + BE_{CW,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year y (tCO2)
$BE_{CW,y}$	=	Baseline emissions due to the production of chilled water to supply the consuming facilities in the absence of the project activity in year y (tCO2/year)
$BE_{EL,y}$	=	Baseline emissions due to the production of electricity to supply the consuming facilities in the absence of the project activity
y	=	Year of the crediting period

Baseline emissions due to the electricity generation ($BE_{EL,y}$)

Baseline emissions due to the electricity generation are calculated by multiplying the net quantity of electricity generated (EG_y) with the CO_2 baseline emission factor for the source of electricity generation to the project ($EF_{electricity,y}$), as follows:

$$BE_{EL,y} = EG_y . EF_{electricity,y} \quad \textbf{(2)}$$

Where:

$BE_{EL,y}$	=	Baseline emissions due to electricity supply to the consuming facilities in the absence of the project activity during the year y (tCO_2/yr)
E_{Gy}	=	Net quantity of electricity supply to the consuming facilities in the absence of the project activity during the year y (MWh)
$EF_{electricity,y}$	=	CO_2 emission factor for the baseline electricity supply to the project activity during the year y (tCO_2/MWh)

Determination of $EF_{electricity,y}$

The determination of the emission factor for baseline electricity generation $EF_{electricity,y}$ depends on the baseline scenario identified:

a. Emission factor for grid electricity

In the absence of the project activity, if the consumers are supplied with electricity from grid-connected sources, the emission factor for the baseline electricity supply correspond to the grid emission factor ($EF_{electricity,y} = EF_{grid,y}$).

The emission factor for grid electricity in year y (tCO_2/MWh) is calculated according to the procedure to determine the combined margin (CM) in the latest version of the “Tool to calculate the emission factor for an electricity system”. $EF_{grid,y}$ corresponds to the parameter $EF_{grid,CM,y}$ in the tool referred to above.

b. Emission factor for a reference captive power plant $EF_{REF,CAP}$

In the absence of the project activity, the electricity demand of consumers is met through a new captive fossil fuel fired power plant installed at the project site or at the consumer site (“reference plant”).

The emission factor for the baseline electricity generation from the reference plant ($EF_{electricity,y}$ = $EF_{REF,CP}$) is calculated according to the procedures described in the latest "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

c. Emission factor for an existing captive power plant

In the absence of the project activity, a fossil fuel based captive power plant supplies the electricity demand of consumers. The emission factor for the baseline electricity generation should be based on the historical performance of the plant and be calculated as ($EF_{electricity,y} = EF_{CP}$), assuming that the efficiency of electricity generation does not change significantly as a result installation of the project activity. Further it is assumed that the composition of fossil fuels fired during the most recent three years would be similar during the crediting period.

The emission factor for the captive power plant (EF_{CP}) is calculated based on the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

d. Combined emission factor for an existing captive power plant and grid

In the absence of the project activity, the consumers may be supplied electricity from grid-connected sources (P2) and also from a captive power plant (P3). The emission factor for the baseline electricity supply should reflect the emissions intensity of the captive power plant and the grid, taking into account an appropriate allocation between baseline electricity supply through captive power and baseline electricity from the grid. For existing consumers, the allocation has to be determined using historical information over the three years prior to the project activity, i.e. if the captive power plant provided 30% of the electricity and the grid 70%, the emission factor should be calculated based on this historical allocation. For new consumers, the most conservative (lowest) emission factor of the two power sources should be used, as it is difficult to determine and justify the ratio of the sources of the hypothetical power supply.

$EF_{electricity,y}$ shall be determined by applying the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

e. Combined emission factor for a reference power plant and the grid

If the baseline scenario is electricity supply from the grid and a reference power plant, the emission factor for the baseline electricity supply should reflect the conservative value between the emissions intensity of the reference power plant and the grid.

$$EF_{electricity,y} = \begin{cases} EF_{REF,CP} \; where \quad EF_{REF,CP} < EF_{Grid} \\ EF_{Grid} \; where \quad EF_{Grid} < EF_{REF,CP} \end{cases} \tag{3}$$

Where:

$EF_{electricity,y}$	=	CO2 emission factor for the baseline electricity supply to the project activity during the year *y* (tCO2/MWh)
$EF_{REF,CP}$	=	CO2 emission factor for the baseline electricity of the reference captive power plant, defined as per the definition of reference plant in the section of baseline scenario (tCO2/MWh). The "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" should be used to determine the factor
EF_{Grid}	=	Emission factor of grid (tCO2/MWh) calculated according to the procedure to determine the combined margin (CM) in the latest version of the "Tool to calculate the emission factor for an electricity system"

Determination of $BE_{EL,y}$

The determination of $BE_{EL,y}$ depends on the most plausible baseline scenario applicable.

a. <u>For new consumers</u>

For new consumers, $BE_{EL,y}$ corresponds to the net quantity of electricity generation in the project plant.

$$BE_{EL,y_y} = EG_{Cogen,y} \quad (4)$$

Where:

$BE_{EL,y}$	=	Baseline electricity consumption in the absence of the project activity in year *y* (MWh)
$EG_{Cogen,y}$	=	Net electricity produced by the cogeneration plant used to supply the consuming facilities in year *y* (MWh)

b. <u>For existing consumers</u>

For existing consumers, $BE_{EL,y}$ corresponds to the lower value between (a) the net quantity of electricity supplied to the consumers from the cogeneration plant and the electricity supplied from the grid and/or captive power plant to consumers (excluding electricity consumption in electrical vapour compression chillers), and (b) the total baseline electricity supply to the consumers (excluding electrical vapour compression chillers), i.e. $EC_{BL,CAP}$, baseline emissions are capped.

$$EG_y = \min\left(\left(EG_{Grid,y} + EG_{Cogen,y} + EG_{CP,y} - EC_{Elechill,y}\right), EC_{BL,CAP}\right) \quad (5)$$

Where:

$BE_{EL,y}$	=	Baseline electricity consumption in the absence of the project activity in year *y* (MWh)
$EG_{Grid,y}$	=	Net electricity supplied by the grid to the consuming facilities in year *y* (MWh)
$EG_{Cogen,y}$	=	Net electricity generated by the cogeneration plant to supply the consuming facilities in year *y* (MWh)
$EG_{CP,y}$	=	Net electricity generated by the captive power plant to supply the consuming facilities in year *y* (MWh)

$EC_{elechill,,y}$ = Total consumption of electricity in the electrical vapour compression chillers remaining in operation after the implementation of the project activity in year *y* (MWh)

$EC_{BL,CAP}$ = Maximum amount of electricity that the consuming facilities would demand to operate at full load capacity prior to the implementation of the project activity (MWh)

c. <u>For existing and new consumers</u>

For existing and new consumers, $BE_{EL,y}$ is the total baseline electricity consumption of existing and new consumers. However the baseline electricity consumption in case of existing consumers is capped.

$$BE_{EL,y_y} = EG_{Ex\_fac,y} + EG_{New\_fac,y} \quad \textbf{(6)}$$

Where:

$BE_{EL,y}$ = Baseline electricity consumption in the absence of the project activity in year *y* (MWh)

$EG_{Ex\_fac,\,y}$ = Baseline electricity consumption in the existing consuming facilities in the absence of the project activity in year *y* (MWh)

$EG_{New\_fac,\,y}$ = Baseline electricity consumption in the new consuming facilities in the absence of the project activity in year *y* (MWh)

$$BE_{EL,New\_fac,y} = EG_{Cogen,New\_fac,y} \quad \textbf{(7)}$$

Where:

$BE_{EL,New\_fac,\,y}$ = Baseline electricity consumption in the new consuming facilities in the absence of the project activity in year *y* (MWh)

$EG_{Cogen,New\_fac,y}$ = Electricity supply to the new consuming facilities by the cogeneration plant in year *y* (MWh)

In case of existing consumers, $EG_{EX\_fac,y}$ corresponds to the lower value between (a) the net quantity of electricity supplied to the existing consumers from cogeneration plant and/or grid and/or captive power plant (excluding energy consumption in electrical vapour compression chillers), and (b) the total baseline electricity supply to the consumers (excluding electrical vapour compression chillers). $EC_{BL,CAP}$, baseline emissions are capped.

$$EG_{Ex\_fac,y} = \min\left(\begin{pmatrix} EG_{Cogen,Ex\_fac,y} + EG_{Grid,Ex\_fac,y} + EG_{CP,Ex\_fac,y} \\ -EC_{Elechill,Ex\_fac,y} \end{pmatrix},\ EC_{BL,CAP}\right) \quad \textbf{(8)}$$

Where:

$EG_{,Ex\_fac,y}$ = Baseline electricity consumption in the absence of the project activity in existing facilities year *y* (MWh)

$EG_{Grid,Ex\_fac,\,y}$ = Net electricity supplied by grid to the existing consuming facilities in year *y* (MWh)

$EG_{Cogen,\,Ex\_fac,y}$ = Net electricity produced by the cogeneration plant to supply the consuming facilities in year *y* (MWh)

$EG_{CP,Ex\_fac,y}$	=	Net electricity produced by the captive power plant to supply the existing consuming facilities in year *y* (MWh)
$EC_{BL,CAP}$	=	Maximum amount of electricity that the consuming facilities would demand to operate at full load capacity prior to the implementation of the project activity (MWh)
$EC_{elechill,Ex\_fac,y}$	=	Total consumption of electricity in the electrical vapour compression chillers in the existing consuming facilities that remain operating after the implementation of the project activity in year *y* (MWh)

Calculation of $EC_{elechill,y}$

The total consumption of electricity in the electrical vapour compression chillers that remain operating after the implementation of the project activity can be determined as per one of the following options:

Option A: Directly monitored electricity consumption in the electrical vapour compression chillers.

Option B: Estimated from the monitored amount of chilled water produced in those chillers and their power consumption function, as per the following equation:

$$EC_{elechill,y} = \Delta l . \sum_{m} \sum_{l=1}^{L} 7.9 \times 10^{4} . \frac{CG_{PJ,elechill,m,l}}{\Delta l} . PCF_{PJ,Elchill,m}\begin{bmatrix} CG_{PJ,elechill,m,l}, \\ T_{Cond,elechill,in,m,l}, \\ T_{Cw,elechill,out,m,l} \end{bmatrix} \quad \textbf{(9)}$$

$$CG_{PJ,elechill,m,l} = CW_{PJ,elechill,m,l} . C_{P} . \left[T_{Cw,elechill,in,m,l} - T_{Cw,elechill,out,m,l} \right] \quad \textbf{(10)}$$

Where:

$EC_{elechill,,y}$	=	Total consumption of electricity in the electrical vapour compression chillers remaining in operation after the implementation of the project activity in year *y* (MWh)
$CG_{PJ,elechill,m,,l}$	=	Total cooling effect produced in the electrical vapour compression chiller *m* remaining in operation after the project activity during the monitoring interval *l* in year *y* (TJ)
$PCF_{PJ,elechill,m(...)}$	=	Output from the power consumption function of the baseline electrical vapour compression chiller *m* remaining in operation after the implementation of the project activity (MW/TR where 1TR=3.517kW).
$T_{cond,elechill,inm,,l}$	=	Average inlet temperature of the condensing water at the inlet of the condenser unit in the electrical vapour compression chiller *m* during the monitoring interval *l* in year *y* (°C)
$T_{cw,elechill,,out,m,l}$	=	Average outlet temperature of chilled water exiting the electrical vapour compression chiller *m* remaining in operation after the project activity during the monitoring interval *l* in year *y* (°C)
$7.9x10^4$	=	Conversion factor from TJ/h to TR
$CW_{PJ,elechill,m,,l}$	=	Amount of chilled water produced by electrical vapour compression chiller *m* remaining in operation after the project activity during the monitoring interval *l* in year *y* (tonnes of chilled water)

$T_{cw,elechill,in,m,l}$	=	Average inlet temperature of chilled water entering the electrical vapour compression chiller *m* remaining in operation after the project activity during the monitoring interval *l* in year *y* (°C)
Cp	=	Specific heat capacity of the chilled water (TJ/tonnes.°C)
l	=	Time intervals used for monitoring chilled water production and chilled water parameters during the year *y*. The number of monitoring intervals is equal to $L = 8760/\Delta l$
Δl	=	Length of the monitoring interval *l*. This length has to be clearly stated in the CDM-PDD. The default Δl is 1 hour. A different length can be proposed, but has to be justified based on the expected time variation of chilled water production rate (load factor) and chilled water parameters (hours)
m	=	Electrical vapour compression chillers that remain in operation after the project activity
y	=	Year of the crediting period

Calculation of $EC_{BL,CAP}$

$EC_{BL,CAP}$ is estimated based on the highest electricity consumption that was observed in the consumers over the most recent three years previous to the implementation of the project activity.

Determination of the power consumption function $PCF_{PJ,elechill,m(...)}$

The power consumption function for electrical vapour compression chillers which remain operating after the implementation of the project activity can, similarly to $PCF_{BL,elechill(...)}$, be determined as:

Option A: Determination of the power consumption function based on measurements, following the procedure provided in the Annex 1 to this methodology.

Option B: Determination of the power consumption function based on manufacturer's data.

Option C: The power consumption function is assumed to be constant by choosing the most conservative value, i.e. the lowest power consumption that is observed, based on measurements or manufacturer's data, following the guidance provided under Option A or Option B above.

Baseline emissions due to the production of chilled water ($BE_{CW,y}$)

Baseline emissions associated with the production of chilled water to be supplied to the consumers in the absence of the project activity in year *y* result from the production of grid electricity that would be required to operate the electrical vapour compression chillers existing in the industrial facility prior to the implementation of the project activity. For existing facilities, since the project activity is supposed to displace existing electrical vapour compression chillers, baseline emissions are capped if the total production of chilled water in the project scenario surpasses $CG_{BL,CAP}$.

Baseline emissions associated with the production of chilled water to supply the consumers in the absence of the project activity in year *y* result from the production of grid electricity that would be required to operate the baseline electrical vapour compression chillers. The determination of $BE_{CW}y$ depends on the baseline scenario identified:

a. For new consumers

In case of new consumers, BE_{CW},y corresponds to the baseline electricity consumption of displaced chiller which would be installed in the absence of the project activity.

$$BE_{CW,y} = \Delta l . EF_{Electricity,y} . \sum_{l=1}^{L} \frac{CG_{PJ,Total,l}}{\Delta l} . PCF_{DS,Elchill} \quad \textbf{(11)}$$

Where:

$BE_{CW,y}$	=	Baseline emissions due to the production of chilled water to supply the consuming facilities in the absence of the project activity in year *y* (tCO2)
$CG_{PJ,Total,l}$	=	Cooling effect produced by the absorption chillers of the project activity (TR) (Refer sections ahead for calculation of this term)
$7.9x10^4$	=	Conversion factor from TJ/h to TR
$PCF_{DS,Elechill}$	=	Output from the power consumption function of the electrical vapour compression chillers (MW/TR), which would have been operating in the absence of the project activity (See the description of reference chiller in the section of identification of baseline scenario). As the chiller is a displaced chiller the Option B of the Annex 1 should be used for determining the PCF, which refers to the manufacturer's data of the displaced (reference) electrical chiller
l	=	Time intervals used for monitoring cooling energy generation (chilled water production) and chilled water parameters during the year *y*. The number of monitoring intervals is equal to L = 8760/Δl
Δl	=	Length of the monitoring interval l. This length has to be clearly stated in the CDMPDD. The default Δl is 1 hour. A different length can be proposed, but has to be justified based on the expected time variation of chilled water production rate (load factor) and chilled water parameters (hours)
$EF_{Electrecity,y}$	=	Emission factor of the electricity source in the year *y* (tCO_2/MW)
y	=	Year of the crediting period

b. For existing consumers:

In case of existing consumers, $BE_{CW,y}$ corresponds to the lower value between (a) the net quantity of chilled water supplied to the consumers from project activity (i.e. absorption chillers and/or electrical vapour compression chillers) and (b) the total baseline chilled water supply to the consumers from existing electrical vapour compression chillers. Since the project activity is supposed to displace existing electrical vapour compression chillers, if the total production of chilled water in the project scenario surpasses $CG_{BL,CAP}$, baseline emissions are capped.

$$BE_{CW,y} = \Delta l . EF_{Electricity,y} . \sum_{l=1}^{L} MIN_{CG,l} . PCF_{BL,Elchill} \begin{bmatrix} MIN_{CG,l}, \\ T_{Cond,in}, \\ T_{Cw,out} \end{bmatrix} \quad \textbf{(12)}$$

$$MIN_{CG,l} = 7.9 \times 10^{4} . \frac{\min\left(CG_{PJ,total,l}, CG_{BL,CAP}\right)}{\Delta l} \quad \textbf{(13)}$$

Where:

$BE_{CW,y}$	=	Baseline emissions due to the production of chilled water to supply the consuming facilities in the absence of the project activity in year *y* (tCO2)
$MIN_{CG,l}$	=	Minimum between $CG_{PJ,total,l}$ and $CG_{BL,CAP}$ (TR)
$7.9x10^4$	=	Conversion factor from TJ/h to TR
$CG_{PJ,Total,,l}$	=	Total cooling effect produced by the cogeneration system (absorption chillers) and electrical vapour compression chillers, which remain operating after the project activity, in the monitoring interval l in year *y* (TJ) (Refer sections ahead for calculation of this term)

$CG_{BL,CAP}$	=	Maximum cooling effect that could have been produced by all electrical vapour compression chillers existing on-site previous to the implementation of the project activity (TJ)
$PCF_{BL,Elechill,m(...)}$	=	Output from the power consumption function of the electrical vapour compression chillers m (MW/TR)
$T_{cond,in,l}$	=	Average inlet temperature of the condensing water as it enters the condenser unit in the absorption chiller m during monitoring interval l in year *y* (°C)
$T_{cw,out,l}$	=	Average outlet temperature of the chilled water as it leaves the condenser unit in the absorption chiller m (cogeneration system) during monitoring interval l in year *y* (°C)
l	=	Time intervals used for monitoring cooling energy generation (chilled water production) and chilled water parameters during the year *y*. The number of monitoring intervals is equal to L = 8760/Δl
Δl	=	Length of the monitoring interval l. This length has to be clearly stated in the CDMPDD. The default Δl is 1 hour. A different length can be proposed, but has to be justified based on the expected time variation of chilled water production rate (load factor) and chilled water parameters (hours)
y	=	Year of the crediting period
$EF_{Electrecity,y}$	=	Emission factor of the electricity source in the year *y*

c. For existing and new consumers

In case of existing consumers, $BE_{CW,Ex\_fac,y}$ corresponds to the cooling energy (chilled water) generation through electrical chillers which are operating prior to the project activity. If the total consumption of chilled water in the existing facilities surpasses $CG_{BL,CAP}$ baseline emissions are capped.

In case of new consumers, $BE_{CW,New\_fac,}y$ corresponds to the baseline electricity consumption of displaced chiller which otherwise would have been built. The baseline electricity consumption for chilled water generation in the electrical chillers in case of existing consumers is capped.

$$BE_{CW,Total,y} = BE_{CW,ex\_fac,y} + BE_{CW,New\_fac,y} \tag{14}$$

Where:

$BE_{,CW,Total,y}$	=	Baseline emissions from the production of chilled water supply to the existing and new consuming facilities in the absence of the project activity in year *y* (tCO2)
$BE_{,CW,Ex\_fac,y}$	=	Baseline emissions from the production of chilled water supply to the existing consuming facilities in the absence of the project activity in year *y* (tCO2)
$BE_{,CW,New\_fac,y}$	=	Baseline emissions from the production of chilled water supply to the new consuming facilities in the absence of the project activity in year *y* (tCO2)

Calculation of $BE_{CW,Ex\_fac,y}$ and $BE_{CW,New\_fac,y}$ should be done as per the guidance provided in equations 15-21 of the methodology.

Calculation of $CG_{PJ,Total,l}$

The total cooling effect produced by the cogeneration system and electrical vapour compression chillers which remain in operation after the project activity is implemented, is calculated as:

$$CG_{PJ,total,l} = CG_{PJ,Cogen,l} + CG_{PJ,Elechill,l} \tag{15}$$

$$CG_{PJ,Cogen,l} = CW_{PJ,Cogen,l} \cdot C_p \left(T_{CW,Cogen,in,l} - T_{CW,Cogen,out,l}\right) \tag{16}$$

$$CG_{PJ,Elechill,l} = \sum_{m}^{l} \left[CW_{PJ,Elechill,m,l} \cdot C_p \left(T_{CW,Elechill,in,m,l} - T_{CW,Elechill,out,m,l}\right)\right] \tag{17}$$

Where

$CG_{PJ,Total,l}$	=	Total cooling effect produced by the cogeneration system (absorption chillers) and electrical vapour compression chillers remaining in operation after the implementation project activity, in the monitoring interval *l* in year *y* (TJ)
$CG_{PJ,Cogen,l}$	=	Total cooling effect produced in the cogeneration system (absorption chiller) during the monitoring interval *l* in year *y* (TJ)
$CG_{PJ,Elechill,l}$	=	Total cooling effect produced in the electrical vapour compression chillers which remain in operation after the project activity during the monitoring interval *l* in year *y* (TJ)
$CW_{PJ,Cogen,l}$	=	Amount of chilled water produced in the cogeneration system (absorption chillers) during the monitoring interval *l* in year *y* (tonnes of chilled water)
Cp	=	Specific heat of the chilled water (TJ/tonne of chilled water °C)
$T_{cw,Cogen,in,m,l}$	=	Average inlet temperature of the chilled water as it enters the absorption chillers (cogeneration system) during the monitoring interval *l* in year *y* (°C)
$T_{CW,Cogen,,out,m,l}$	=	Average outlet temperature of the chilled water as it leaves the absorption chillers (cogeneration system) during the monitoring interval *l* in year *y* (°C)
$CW_{PJ, Elechill,m,l}$	=	Amount of chilled water produced by electrical vapour compression chiller *m* that remain in operation after the project activity during the monitoring interval *l* in year *y* (tonnes of chilled water)
$T_{cw,Elechill,In,m,l}$	=	Average temperature of the chilled water as it enters the electrical vapour compression chiller *m* that remain in operation after the project activity during the monitoring interval *l* in year *y* (°C)
$T_{CW,Elechill,,out,m,l}$	=	Average temperature of the chilled water as it leaves the electrical vapour compression chiller *m* that remain in operation after the project activity during the monitoring interval *l* in year *y* (°C)
l	=	Length of the monitoring interval *l*. This length has to be clearly stated in the CDMPDD
m	=	Existing electrical vapour compression chillers in the existing consuming facilities prior to the project activity
Δl	=	Length of the monitoring interval *l*. This length has to be clearly stated in the PDD
y	=	Year of the crediting period

Calculation of $CG_{BL,CAP}$

For existing consumers, the baseline emissions ($CG_{BL,CAP.}$) are capped at the nameplate chilled water output in the existing chillers, as follows:

$$CG_{BL,CAP} = \Delta l . \sum_{m} \left[CAP_{BL,Elechill,m} . C_p . \left(T_{BL,CW,in,m} - T_{BL,CW,out,m} \right) \right] \quad \textbf{(18)}$$

Where:

$CG_{BL,CAP}$	=	$CG_{BL,CAP}$ should be chosen based historic values. It is the maximum cooling effect produced by the baseline electrical chillers during the most recent three years prior to the implementation of the project activity (TJ)
$CAP_{BL,elechill,m}$	=	Nameplate cooling output from the existing electrical vapour compression chiller *m*, prior to the project activity when operating at maximum output capacity during the monitoring interval *l* (tonnes of chilled water/hour)
Cp	=	Specific heat of the chilled water (TJ/tonne of chilled water °C)
$T_{BL,cw,in,m}$	=	Average temperature of the chilled water entering the electrical vapour compression chiller *m*, existing in the consumers prior to the project activity (^{o}C)
$T_{BL,cw,out,m}$	=	Average temperature of the chilled water leaving the electrical vapour compression chiller *m*, existing in the consumers prior to the project activity (^{o}C)
Δl	=	Length of the monitoring interval *l*. This length has to be clearly stated in the PDD
m	=	Existing electrical vapour compression chillers in the existing consumers prior to the project activity

Determination of the power consumption function $PCF_{elechill(...)}$

The power consumption function $PCF_{,elechill(...)}$ of the existing electrical vapour compression chillers prior to the implementation of the project activity is not a single value, rather it is a relation which expresses the power consumption of the electrical vapour compression chillers as a function of the quantity of chilled water produced, the outlet temperature of chilled water and the inlet temperature of condensing water. This curve can be either presented as a mathematical function or as a look-up table.

Given the power consumption function of a chiller, its power consumption is estimated by applying the average values of chilled water produced, outlet temperature of chilled water and inlet temperature of condensing water, monitored during the monitoring intervals *l*, to the power consumption function of the chiller.

For the purpose of establishing the power consumption function, project participants should determine and document in the CDM-PDD the maximum range over which the three key operating parameters (chilled water produced, the outlet temperature of chilled water and the inlet temperature of condensing water) can vary in the electrical vapour compression chillers. Preferably, historical data for at least one year should be used for this purpose. The range should reflect the range of year-round ambient temperature and humidity conditions and cooling demand variations. Different ambient conditions (temperature and humidity) are reflected through different inlet temperature of the condensing water (as the operation of the cooling tower depends on ambient temperature and humidity) and different chiller output loads (as the cooling demand usually is influenced by the ambient temperature). The range of the inlet temperature of the condensing water can be determined based on data of the wet bulb and dry bulb temperatures specific to the location of the chillers and information on the variation of humidity and ambient temperature, covering each season in the year and variations during days and nights. In the absence of more precise data, it may be assumed that the inlet temperature of the condensing water is 4 °C higher than the average ambient wet bulb temperature. The range of the outlet temperature of the chilled water should be varied according to the cooling process or air conditioning requirements. However, in some applications the outlet temperature of the chilled water may be kept relatively constant, making the variation of this parameter unnecessary.

The power consumption function for each electrical vapour compression chiller can be determined in one of the following ways:

Option A: Determination of the power consumption function based on measurements, described by procedure provided in the Annex 1 in this methodology.

Option B: Determination of the power consumption function based on manufacturer's data, following the guidance provided in Step 5 of the Annex 1 in this methodology.

Option C: The power consumption function is assumed to be constant (and not dependent on the quantity of chilled water produced, the outlet temperature of the chilled water and the inlet temperature of the condensing water). In this case, the value for the power consumption function should be chosen as the most conservative value, i.e. the lowest power consumption that is observed over the maximum range of the three operating parameters. This value can either be determined based on measurements or manufacturer's data, following the guidance provided under Option A or Option B above.

If more than one electrical vapour compression chiller had been operating before the implementation of the project activity, a single equivalent value of power consumption should be used by calculating the arithmetic average of the power consumptions of the chillers, obtained from the individual power consumption functions determined as per one of the options above, at each level of chilled water produced, outlet temperature of chilled water and inlet temperature of condensing water.

Power consumption function $PCF_{,elechill(...)}$ for a chiller which would have been operating in the absence of the project activity (displaced chiller) should also be determined as per the guidance of Annex 1, however Option B (Determination of the power consumption function based on manufacturer's data) should be chosen to determine the PCF of a displaced chiller.

Project Emissions

Project emissions include the following:

- Emissions related to fuel consumption of cogeneration plant during year *y*;
- Project emissions related to electricity consumption of project activity during year *y*.[4]

Project emission should be calculated based on "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", making the element processes j correspond to the combustion of fossil fuels for the main and auxiliary supplies of the cogeneration system in year *y*.

Project emissions are calculated as follows:

$$PE_y = PE_{FC,y} + PE_{EL,y} \quad \textbf{(19)}$$

[4] The project activity may have electricity consumption from grid for its auxiliary consumption and during the start-up.

Where:

PE_y	=	Project emissions in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel combustion in year *y* (t CO_2/yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption in year *y* (t CO_2/yr)
y	=	Year of the crediting period

Calculation of $PE_{FC,y}$

$PE_{FC,y}$ should be calculated as the parameter $PE_{FC,j,y}$ in the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", making the element processes *j* correspond to the combustion of fossil fuels for the main and auxiliary supplies of the cogeneration system in year *y*.

Calculation of $PE_{EL,y}$

$PE_{EL,y}$ should be calculated as the parameter $PE_{EL,y}$ in Scenario A in the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", making the element *j* in the parameter $EC_{PJ,j,y}$ of the Tool as the industrial facilities.

Leakage

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH4 emissions and CO2 emissions from associated fuel combustion and flaring. The leakage is determined by applying the calculations provided in the Leakage section of AM0029.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \qquad \textbf{(20)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
PE_y	=	Project emissions in year *y* (t CO_2/yr)
LE_y	=	Leakage emissions in year *y* (t CO_2/yr)

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

In the 2nd and 3rd crediting period the methodology should check the following steps.

The procedure to select the baseline scenario, as outlined in the tool mentioned above, should be applied to assess whether the chosen baseline scenario is still valid. The parameters included in monitored (or non-monitored) data need to be updated at the renewal of the crediting period.

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

Data and parameters not monitored

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

Data / parameter:	$CAP_{BL,elechill,m}$
Data unit:	tonnes of chilled water/hour
Description:	Nominal cooling output that the electrical vapour compression chiller m, existing at the consumer site prior to the project activity, would be able to deliver if it would operate at its maximum output capacity during a time interval equal to *l*
Source of data:	Manufacturers data
Measurement procedures (if any):	
Any comment:	Data needs to be cross verified & checked with PO of the equipment

Data / parameter:	$T_{BL,CW,in,m}$
Data unit:	^oC
Description:	Average temperature of the chilled water entering the electrical vapour compression chiller *m*, existing in the consumers prior to the project activity
Source of data:	Historical average measurements (3 years) of temperature $T_{BL,cw,in,m}$ for chiller *m*.
Measurement procedures (if any):	
Any comment:	-

Data / parameter:	$T_{BL,CW,out,m}$
Data unit:	^oC
Description:	Average temperature of the chilled water leaving the electrical vapour compression chiller *m*, existing in the consumers prior to the project activity
Source of data:	Historical average measurements (3 years) of temperature $T_{BL,cw,in,m}$ for chiller *m*
Measurement procedures (if any):	
Any comment:	-

Data / parameter:	C_p
Data unit:	TJ/tonne of chilled water ^oC
Description:	Specific heat of chilled water
Source of data:	Use references in standard engineering books or appropriate thermodynamic Models
Measurement procedures (if any):	
Any comment:	-

Data / parameter:	$PCF_{BL,elechill(...)}$
Data unit:	MW/TR
Description:	Power consumption function of the electrical vapour compression chillers existing onsite prior to the implementation of the project activity
Source of data:	As specified in the Annex 1 of the baseline methodology
Measurement procedures (if any):	
Any comment:	

Data / parameter:	$PCF_{DS,elechill,}$
Data unit:	MW/TR
Description:	Power consumption function of the electrical vapour compression chiller would have been operating in the absence of the project activity (reference chiller)
Source of data:	As specified in the baseline methodology
Measurement procedures (if any):	As per the Option B of the Annex 1 of the methodology based on manufacturers data
Any comment:	See the description of reference chiller in the section of identification of baseline scenario. As the displaced chiller would have been operating in the absence of the project activity, the manufacturer's data is the only way for determining the PCF of reference chiller

Data / parameter:	$EC_{BL,CAP}$
Data unit:	MWh
Description:	Maximum annual amount of electricity that the consumers would demand to operate at full load capacity prior to the implementation of the project activity
Source of data:	Historical measurements (3 years) of electricity consumed by the consuming Facilities
Measurement procedures (if any):	
Any comment:	

Data / parameter:	$EF_{REF,CP}$
Data unit:	*(tCO2/GJ)*
Description:	CO_2 emission factor for the fossil fuel type that would in the absence of the project activity be used in the reference plant
Source of data:	Use the IPCC default value of the fuel type identified as part of the baseline scenario selection procedure at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	n/a
Any comment:	The data will be used for determination of baseline emission

III. MONITORING METHODOLOGY

Monitoring procedures

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

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

Key parameters to be monitored for baseline emissions include:

- Electricity generated by the project activity;
- Chilled water generated by the project activity.

It is assumed that the data provided for the electricity grid and from individual consumer facilities are available and transparent.

Data and parameters monitored

Following data and parameters are to be monitored in the project activity

Data / parameter:	$EG_{Cogen,y}$
Data unit:	MWhe
Description:	Gross Electricity generated by the cogeneration System in year *y*
Source of data:	Electricity meters installed with the output of the cogeneration system
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Electricity supplied by the grid/consumers will be used for cross checking of emission. The hourly data will be archived electronically
Any comment:	-

Data / parameter:	$EG_{Grid,y}$
Data unit:	MWhe
Description:	Total consumption of grid electricity at the consumer sites in year *y*
Source of data:	Use electricity meters in the interconnection point with the power grid
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross check measurement results with records or invoices for purchased and sold electricity
Any comment:	-

Data / parameter:	$EG_{CP,y}$
Data unit:	MWhe
Description:	Total generation of electricity from the captive power plants at the consumer sites in year *y*
Source of data:	Use electricity meters in installed at the captive power plants.
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross check measurement results with consumption records or invoices for purchased and sold electricity
Any comment:	-

Data / parameter:	$EG_{Backup\_CP,y}$
Data unit:	MWh_e
Description:	Total generation of electricity from the backup power generating units in the consumers in year *y*
Source of data:	Use electricity meters installed at the backup power generating units.
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross check measurement results with consumption records or invoices for purchased and sold electricity
Any comment:	The total electricity generation from backup power generating units is capped to ensure that emission reductions are not claimed as a result of increased capacity after implementation of the project activity. The cap is 5% of the total capacity of the cogeneration facility, i.e. the electricity generated from the backup generating units cannot be more than 5% of the yearly generation of electricity by the project activity. In case the backup plant generate more than the 5% of the energy, the PP should submit the proper documentary evidences in the monitoring reports to substantiate the electricity usage of the back-up generating units (such non availability of gas from the suppliers, etc). The justification has to be evaluated by DoE to ensure that no capacity increase of electricity generation takes place

Data / parameter:	$EG_{Total,y}$
Data unit:	MWh_e
Description:	Total electricity consumed at consumer site in year *y*
Source of data:	Use electricity meters installed at the consumer sites
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross check measurement results with consumption records or invoices for purchased electricity

Any comment:	If the electricity demand at a consumer facility (existing consumers) increases up to 10% above the maximum observed in a 3 years period prior to the project activity, for a cumulative period longer than 3 months during the crediting period and this increased demand is supplied by the project cogeneration system and the remaining (old) equipment (and/or grid), the emission reductions generated from producing all the electricity supplied to this consumer must be excluded up to the end of the crediting period. The DoE has to check the historical electrical consumption of consumers and compare to electricity consumed during the project activity This parameter is not used in any equation, but used for demonstration of compliance with applicability condition

Data / parameter:	$CW_{Total,i,y}$
Data unit:	MWhe
Description:	Total chilled water used at consumer site i in year *y*
Source of data:	Use flow meters installed at the consumer sites or calculate
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross check measurement results with consumption records or invoices for purchased water
Any comment:	For existing consumers, if the chilled water demand at a consumer facility increases up to 10% (above the maximum observed in a 3 years period prior to the project activity), for a cumulative period longer than 3 months during the crediting period and this increased demand is supplied by the project cogeneration system and the remaining (old) equipment, the emission reductions generated from producing all the chilled water supplied to this consumer must be excluded up to the end of the crediting period. For a new consumer, the project activity chilled water consumption should be compared to the design chilled water consumption for each customer. The DoE has to check at least one of the following the following to compare with the total chilled water consumed in the project activity (1) Design chilled water consumption figure for the consumer; (2) Historical chilled water consumption of consumers

Data / parameter:	$T_{CW,Cogen,in,l}$
Data unit:	°C
Description:	Average inlet temperature of the chilled water as it enters the absorption chillers (Cogeneration system) during the monitoring interval *l*
Source of data:	Measurements by project participants
Measurement procedures (if any):	
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{CW,Cogen, out,l}$
Data unit:	°C
Description:	Average outlet temperature of the chilled water as it leaves the absorption chillers (Cogeneration system) during the monitoring interval *l*
Source of data:	Measurements by project participants
Measurement procedures (if any):	
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{cw,elechill,in,m,l}$
Data unit:	°C
Description:	Average inlet temperature of the chilled water as it enters the electrical Chiller m (running parallel during the project activity) during the monitoring interval *l*
Source of data:	Measurements by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{cw,elechill,out,m,l}$
Data unit:	°C
Description:	Average outlet temperature of the chilled water as it leaves the electrical Chiller m (running parallel during the project activity) during the monitoring interval *l*
Source of data:	Measurements by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$CW_{Pj,Cogen,l}$
Data unit:	Tonnes of chilled water
Description:	Amount of chilled water produced in the cogeneration system (absorption chillers) during the monitoring interval *l*
Source of data:	Plant data
Measurement procedures (if any):	Flow meter applying required conversion factor for units
Monitoring frequency:	Δl
QA/QC procedures:	Flow meter should be calibrated for temperature and pressure of chilled water to be monitored as per internal QA/QC procedures of plant
Any comment:	-

Data / parameter:	$CW_{Pj,elechill,m,l}$
Data unit:	tonnes of chilled water
Description:	Amount of chilled water produced in the electrical vapour compression chiller m during the monitoring interval *l*
Source of data:	Plant data
Measurement procedures (if any):	Flow meter applying required conversion factor for units
Monitoring frequency:	Δl
QA/QC procedures:	Flow meter should be calibrated for temperature and pressure of chilled water to be monitored as per internal QA/QC procedures of plant
Any comment:	Data should be cross checked with the consumption records/sales records

Data / parameter:	$T_{Cogen,cond,in,l}$
Data unit:	°C
Description:	Average inlet temperature of the condensing water as it enters the condenser unit in the absorption chillers (Cogeneration system) during the monitoring interval *l* in year *y*
Source of data:	Measurements by project participants -
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{Cogen,cond,out,,l}$
Data unit:	°C
Description:	Average outlet temperature of the condensing water as it leaves the condenser unit in the absorption chillers (COGENERATION system) during the monitoring interval *l* in year *y*
Source of data:	Measurements by project participants -
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{elechill,cond,in,m,l}$
Data unit:	°C
Description:	Average inlet temperature of the condensing water as it enters the condenser unit in the electrical vapour compression chillers during the monitoring interval *l* in year *y*
Source of data:	Measurements by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$T_{elechill,cond,out,m,l}$
Data unit:	°C
Description:	Average outlet temperature of the condensing water as it leaves the condenser unit in the electrical vapour compression chillers during the monitoring interval *l*
Source of data:	Measurements by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, average values to be determined for each time period *l*
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

Data / parameter:	$EC_{elechill,y}$
Data unit:	MWh
Description:	Electricity consumed by the electrical vapour compression chillers which remain operational during the project activity during the year *y*
Source of data:	Electric meters mounted on the electrical chillers by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	Measurements equipments will be calibrated periodically for proper recording
Any comment:	-

IV. REFERENCES AND ANY OTHER INFORMATION

Methodologies

(1) ACM0002 / Version 06: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources";

(2) ACM0006 / Version 06: "Consolidated methodology electricity generation from biomass residues";

(3) ACM0009: "Consolidated baseline methodology for industrial fuel switching from coal or petroleum fuel to natural gas";

(4) AM0029 / Version 02: "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas";

(5) AM0048 / Version 02: "New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels";

(6) AMS IIH: "Energy efficiency measures through centralization of utility provisions of an industrial facilities";

(7) AM0058: "Introduction of a new primary district heating system";

(8) AM0060: "Power saving through replacement by energy efficient chillers".

Tools

(1) Tool to calculate the emission factor for an electricity system;

(2) Tool to calculate baseline, project and/or leakage emissions from electricity consumption;

(3) Tool for the demonstration and assessment of additionality;

(4) Combined tool to identify the baseline scenario and demonstrate additionality;

(5) Tool to determine remaining lifetime of equipment.

Annex 1: Procedure to determine the power consumption function of chillers

The power consumption function is established for each electrical vapour compression chiller used to supply chilled water to the consumers.

The power consumption function *PCFelechill,m(...)* for the project scenario electrical vapour compression chillers.

The power consumption function (*PCF)* or baseline efficiency profile of chiller is established under different chiller outputs (*OUPm*), inlet temperatures of the condensing water (*Tcond,in*) and outlet temperatures of the chilled water (*Tcw,out*) to reflect the representative range of year-round ambient temperature and humidity conditions. The power consumption function should be measured through the steps outlined below. The measurement results and the derivation of the power consumption function should be documented transparently in the CDM-PDD or the first monitoring report.

Step 1: Ensure chiller is maintained properly before experiment

Ensure that the chiller is filled with the correct quantity of refrigerant and the scaling in the condenser unit and evaporator unit is removed. In addition, preventive maintenance of the chiller should be done prior to carrying out the measurements.

Step 2: Define the operating conditions for which measurements are carried out

The measurements for the chiller should be carried out for the maximum range of variation of the chiller output (*OUPm*), the inlet temperatures of the condensing water (*Tcond,in*) and the outlet temperatures of the chill water (*Tcw,out*). For this purpose, project participants should identify discrete operation points for which steady-state measurements are carried out. For example, if the chiller output (*OUPm*) varies from 0 to 100 TR, discrete measurement points may cover chiller outputs of 20, 40, 60, 80 and 100 TR. The discrete measurement points should cover applicable combinations of the three parameters (*OUPm*, *Tcond,in* and *Tcw,out*).

Step 3: Install the necessary measurement equipment

Install the necessary measurement equipment to measure the following parameters:

- Power consumption of the chiller (*PC*);
- Inlet temperatures of the condensing water (*Tcond,in*);
- Outlet temperatures of the chill water (*Tcw,out*);
- Flow of the chill water (*q*).

The guidance provided in the monitoring methodology should be followed when measuring these parameters.

Step 4: Carry out measurements

Measure the parameters identified in step 3 for each discrete operation point identified in step 2, by operating the chiller at the discrete operating conditions. The discrete operating points can, *inter alia*, be generated by the following means:

- The chilled water flow may be varied with the help of a valve or variable speed drive or starting or stopping the number of pumps distributing the chilled water to consumers;
- The different inlet temperatures of the condensing water (*Tcond,in*) can be generated by installing a water conditioning device (including chiller/heater) at the inlet of the condenser unit to produce the desired cooling water temperature. This conditioning device may, *inter alia*, work on following principles:

- Electric heaters (or hot water) and chilled water pipes are installed;
- The device can also be a type of mixer, which can facilitate addition of small amount of chilled water in the inlet condensing water. In the case that several chillers operate in parallel, having a common condensing water and/or chilled water circuit, isolating one chiller for the purpose of the experiment can influence the operation of other chillers. In such cases, either the chiller under experiment will require a separate water circuit or will have to be isolated from the other chillers for the time of experiment.

Step 5: Establish the power consumption function

Calculate the chiller output (*OUP*) in TR for each discrete operation point. Establish for each discrete operation point all four parameters (*PC*, *OUP*, *Tcond,in* and *Tcw,out*) of the power consumption function in a table. An example is provided Table A below:

Table A: Example of data collected to establish the power consumption function

Specific power consumption (*PC* in MW/TR)	Chiller output (OUP in TR)	Inlet temperature of the condenser water(*Tcond,in* in °C)	*Outlet temperature of the chill water(*Tcw,out *in °C)*
88	100	40°C	*6°C*
78	100	40°C	*8°C*
73	100	40°C	*°C 10*
75	100	40°C	*12°C*
70	100	40°C	*6°C*
73	100	30°C	*8°C*
68	100	30°C	*10°C*
65	100	30°C	*12°C*
66	100	30°C	*6°C*
64	100	20°C	*8°C*
62	100	20°C	*10°C*
88	100	40°C	*12°C*
80	100	40°C	*6°C*

The power consumption function may be established by the following two ways:

- Use a look-up table, as the one provided in Table A, as the power consumption function. To ensure a conservative approach, for each period *t* the more conservative should be selected if the monitored data operating parameters *(OUPt, Tcond,in,t, Tcw,out,t)* are between the discrete operation points provided in the look-up table. For example: If the monitored chiller output is 90 TR, the inlet temperature of the condenser water is 35°C and the outlet temperature of the chill water is 7°C, the lowest value for the specific electricity consumption among the following eight data sets should be used:

  OUP = 100 TR; Tcond,in = 40°C; Tcw,out = 6°C
  OUP = 100 TR; Tcond,in = 40°C; Tcw,out = 8°C
  OUP = 100 TR; Tcond,in = 30°C; Tcw,out = 6°C
  OUP = 100 TR; Tcond,in = 30°C; Tcw,out = 8°C
  OUP = 80 TR; Tcond,in = 40°C; Tcw,out = 6°C
  OUP = 80 TR; Tcond,in = 40°C; Tcw,out = 8°C
  OUP = 80 TR; Tcond,in = 30°C; Tcw,out = 6°C
  OUP = 80 TR; Tcond,in = 30°C; Tcw,out = 8°C

Develop a mathematical expression *(PCF = f(OUPt, Tcond,in,t, Tcw,out,t))* that correlates the three operating parameters, OUPt, Tcond,in,t, Tcw,out,t, with the electricity consumption. In doing so, conservativeness should be ensured by requiring that the result of the function, when applied to the discrete operation points, is on average the same or lower than the specific electricity consumption measured.

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History of the document

Version	Date	Nature of revision(s)
01	EB 51, Annex # 04 December 2009	To be considered at EB 51.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		