GLOBAL CARBON COUNCIL

Driving Climate Actions

# Energy Efficiency Measures in existing Centralized Cooling Systems

GCCM006

V1.0 - 2025

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# CONTENTS

# 1. Baseline and monitoring methodologies of GCC

1. Global Carbon Council (GCC) is MENA region's first and only voluntary carbon offsetting program that aims to contribute to a vision of sustainable and low carbon economy of the region and help to catalyze climate actions on the ground. Refer to www.globalcarboncouncil.com for details.

2. GCC methodologies provide detailed procedures for project owners to calculate the emissions reductions of their projects, monitor these emission reductions and develop the project submission form.

3. This methodology is for project activities aimed at increasing energy efficiency and reducing energy consumption of existing centralized cooling systems, through various means including the introduction of system optimization measures and/or one-to-one replacement of the chillers with more energy efficient ones.

# 2. Source/s of this baseline and monitoring methodology

4. For the development of GCC methodologies, the requirements of the 'GCC Program Manual' (paragraphs 43-46) and the 'Standard for Development of Methodologies' are applied. The determination of the baseline scenario and baseline emissions are consistent with the UNFCCC's Clean Development Mechanism (CDM) guideline "Guideline for determining baselines for measure/s" (Baseline Guideline), referred to in the above standard.

5. This methodology is based on the following baseline and monitoring methodologies of the CDM:

   - AM0060: "Power saving through replacement by energy efficient chillers";
   - AMS-II.C: "Demand side energy efficiency activities for specific technologies";
   - AM0117: "Introduction of a new district cooling system".
   - AM0061: "Methodology for rehabilitation and/or energy efficiency improvement in existing power plants"

6. This methodology also refers to the latest approved versions of the following tools and guidelines of the CDM:

   - TOOL 02: "Combined tool to identify the baseline scenario and demonstrate additionality";
   - TOOL 03: "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion";
   - TOOL 05: "Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation";
   - TOOL 07: "Tool to calculate the emission factor for an electricity system";
   - TOOL 10: "Tool to determine the remaining lifetime of equipment";
   - TOOL 27: "Investment analysis";
   - TOOL 28: "Calculation of baseline, project and leakage emissions from the use of refrigerants";
   - Standard: Sampling and surveys for CDM project activities and programme of activities.

# 3. Description of key terms

7. The following description of key terms applies to the projects using this methodology:

| Sr. No. | Key Term | Description |
|---|---|---|
| **1** | Cooling capacity | The total amount of cooling provided to an enclosed area in a specified amount of time in thermal Watts ($W_{th}$) |
| **2** | Fixed speed air conditioner | Refers to air conditioners for which the compressor runs only at one speed, with a constant number of rotations per unit time. The air conditioner can only be switched on or off to maintain a room temperature. In many countries there are separate Standard & Labelling systems for fixed speed air conditioners as they tend to be less efficient than others |
| **3** | Inverter air conditioner | Refers to air conditioners that have an inverter allowing variability and reduced speed of the compressor, so that the cooling output can be varied across a wide range. Inverter air conditioners are more expensive and efficient and have rapidly gained market share in many countries |
| **4** | Unitary air conditioners | A central air conditioner consisting of one or more factory- made assemblies that include an evaporator or cooling coil and an electrically driven compressor and condenser combination. |
| **5** | Refrigerant | Chemicals circulating in a thermodynamic process in refrigeration or air conditioning equipment. An average air conditioner contains about one litre (about 1.2 kg) of refrigerant per ton of the AC unit. Refrigerants leak slowly out of the appliance, so it needs to be refilled periodically. Air conditioners need this maintenance every one or two years. |
| **6** | Building | Individual construction that is either a residential, public or commercial consumer of centralized cooling |
| **7** | Coolant | A fluid that draws off heat by circulating through a cooling system |
| **8** | Centralized cooling system | A system for distributing a centrally generated coolant (e.g. cooled/chilled water) to existing and/or new buildings and/or industrial facilities. A centralized cooling system supplies coolant to an area of several buildings and industrial facilities, i.e., a neighbourhood or a city. It includes the centralized cooling plants and cooling distribution network. |
| **9** | Seasonal Energy Efficiency Ratio (SEER) | The ratio of the total amount of cooling energy provided in the actual conditions at site, divided by the total energy input to the cooling plant summed over the year. |

| | | |
|---|---|---|
| **10** | Measure | An efficiency measure is defined as the smallest combination of actions that would result in an energy efficiency improvement if it was implemented independently. |
| **11** | Package of measures | A package of measures is the combination of measures that are interdependent. Measures are considered to be interdependent when the resulting energy efficiency improvement of one measure is influenced by the implementation of another. |
| **12** | Set of Measures | A set of measures includes “a Measure” and “Package of Measures” |

# 4. Applicable Project Activities and their Eligibility Conditions

8. The project activities eligible under this methodology aim to optimize the energy efficiency of existing centralized cooling systems, either a vapour compression or vapour absorption technology-based, and to reduce the energy consumption of the existing centralized cooling systems through various measures.

9. Only Supply-side energy efficiency measures are eligible under this methodology. Demand-side energy efficiency measures are not eligible.

10. The various energy efficiency measures at the centralized cooling plant include but are not limited to the following:

    - Replacement of chiller, condenser, pumps, and other components of centralized cooling plant with more efficient technologies;
    - Retrofit of chiller, condenser, pumps, and other components of centralized cooling plant to improve energy efficiency;
    - Variation of the refrigerant compressor speed in a vapour compression system to meet cooling demand and to save energy;
    - Improvement in steam/hot water generation efficiency in a steam/hot water generator or the utilization efficiency of the regenerator of a vapour absorption system;
    - Variation in the chilled water (or any other coolant) circulation rate in the cooling network to meet cooling demand and to save energy;
    - Variation in the condenser water circulation rate in the condenser water network to meet cooling demand and to save energy;
    - Variation in the fan speed or change of fan material in cooling towers leading to a lower condenser water temperature, which positively affects chiller efficiency;
    - Introduction of easy integration of system components (including drives) into a SCADA system;
    - Inclusion of fully integrated, cooling-specific digital applications for centralized cooling operation optimization.

11. The energy efficiency measures in para 10 shall not primarily aim to increase the rated capacity of the centralized cooling system. The methodology is applicable to the project

activity if, prior to the implementation of the efficiency measure, the cooling system was served by several system components (e.g. compressors, cooling tower, pumps, operating system and all heat exchangers such as VAM[1] generator, VAM absorber, evaporators, condensers) and as part of the project activity, one or several of the existing components are replaced by corresponding new component (s). For each component replacement, the rated output capacity of the new component shall not be significantly larger or smaller (maximum ±5%) than the rated output capacity of the existing component. Please refer to $CAP_{BL,design,}$ and $CAP_{PJ,design,y}$ in the monitored/not monitored parameters.

12. The methodology is only applicable to project activities that are implemented in an existing centralized cooling system and do not involve the installation and commissioning of new additional cooling generation units. The quality of cooling output (e.g. temperature and flow of chilled water supply) during the project activity shall not significantly change to meet the demand side requirements.

13. The methodology is only applicable if the most plausible baseline scenario is the "continuation of prevailing practice".

14. Emission reductions[2] that are gained due to a switch of energy sources shall not be claimed by applying this methodology alone. Therefore, emission reductions due to displacement of the baseline energy source can be claimed by applying this methodology in combination with another relevant approved methodology. In doing so, interactive effects shall be considered as per the CDM "Guidelines for the consideration of interactive effects for the application of multiple methodologies for a programme of activities". A fuel switch to a more carbon intensive energy source is not applicable under this methodology.

15. Emission reductions can be claimed only up to the end of the remaining lifetime of the existing centralized cooling systems based on the entire system wise approach which is to be determined following the latest CDM TOOL 10: "Tool to determine the remaining lifetime of equipment".

16. When the project activity involves replacement of chillers, the existing chiller, which is replaced under the project activity, shall be scrapped in line with the policy in the host country and scrapping shall be monitored and demonstrated with credible evidence.

17. In cases where the project activity includes replacement of chillers, the refrigerant contained in the existing chiller shall be recovered and destroyed. The destruction of refrigerant gases shall be conducted using a method approved under regulations existing in the host country. If there is no regulation in the host country, the best international practices are to be followed, and the destruction of the refrigerant gases shall be monitored and demonstrated with credible evidence[3].

## 5. Sectoral Scope applicable to GCC verifier

18. The sectoral scopes eligible under GCC have been defined in section 3.2 of 'Standard for Development of Methodologies'.

[1] Vapour Absorption Chiller Machine

[2] In the event of a transition from a carbon-intensive energy source to a less carbon-intensive one, baseline emissions, project emissions, leakage, and the monitoring of relevant parameters will be considered in accordance with another applicable approved methodology.

[3] In cases where the project activity is not yet implemented, the scrapping of replaced equipment (components) and destruction of recovered refrigerant shall be demonstrated in the first monitoring report and to be verified during the first verification.

19. Only a third-party verifier approved under GCC for the sectoral scopes 01 “Energy industries” (renewable / non-renewable sources) and scopes 03 “Energy Demand” can conduct the Validation and Verification of a GCC project that applies this methodology.

## 6. Project Boundary

20. The spatial extent of the project boundary includes the centralized cooling systems up to the substation and excludes the cooling energy supply piping network or demand side equipment. The GHGs included in or excluded from the project boundary are listed in Table 1.

**Figure 1:** Diagram of the project boundary

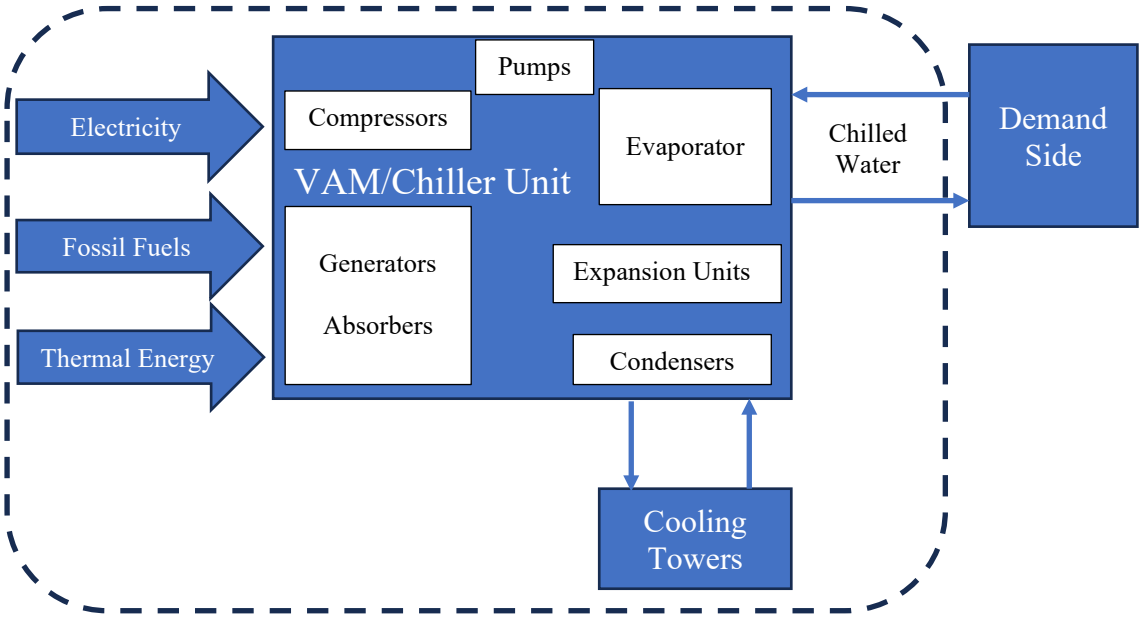

**Table 1: Emission sources included in or excluded from the project boundary.**

| Source | | GHG | Included | Justification/explanation | Determination of Emissions |
|---|---|---|---|---|---|
| Baseline | Electricity and/or thermal energy consumed by baseline centralized cooling systems | CO2 | Yes | Main source of emissions | As per baseline emissions section |
| | | CH4 | No | Excluded for simplification | Not significant |
| | | N2O | No | Excluded for simplification | Not significant |
| | Leakage of refrigerant from baseline chillers | Refrigerants that are GHGs | Yes | Could be a significant source of emissions | As per leakage section |
| Project Activity | Electricity and /or thermal energy consumed by project centralized cooling systems | CO2 | Yes | Main source of emissions | As per project emissions section |
| | | CH4 | No | Excluded for simplification | Not significant |
| | | N2O | No | Excluded for simplification | Not significant |
| | Leakage of refrigerant from new chillers | Refrigerants that are GHGs | Yes | Could be a significant source of emissions | As per leakage section |
| | Leakage of refrigerants contained in the existing chiller | Refrigerants that are GHGs | Yes | Could be a significant source of emissions | As per leakage section |

## 7. Baseline scenario

21. The baseline scenario shall be determined following the provisions of CDM TOOL 02: “Combined tool to identify the baseline scenario and demonstrate additionality”.

22. In applying the above tool, all the realistic and credible baseline scenario shall be assessed. However, the methodology is only applicable if the most plausible baseline scenario is the “continuation of prevailing practice”.

## 8. Additionality

23. An additionality is to be assessed and determined following the provisions of CDM TOOL 02: “Combined tool to identify the baseline scenario and demonstrate additionality”;

24. As part of the project, a set of the energy efficiency measures to be implemented in the centralised cooling plant are to be listed down prior to the investment decision.

25. When Step 3. Investment analysis and Investment comparison analysis is applied; the analysis shall be conducted for each eligible measure or a package of measures planned to be implemented in a specific centralized cooling plant in the course of the project activity. The latest approved version of the CDM TOOL 27 “Investment analysis” shall be considered when conducting the investment analysis. When the investment analysis is conducted for measures aimed at replacing existing equipment with new equipment or retrofitting existing equipment, the cash flow statement shall be prepared for the remaining

lifetime of the equipment. The remaining lifetime of the baseline equipment shall be determined using the latest approved version of the CDM TOOL10: "Tool to determine the remaining lifetime of equipment".

26. Common practice analysis of the latest approved version of the CDM Tool 24: Common Practice[4] shall be conducted for each eligible measure or a package of measures in the set of measures planned to be implemented in each centralized cooling plant.

27. If, as the outcome of the common practice analysis, a particular measure is regarded to be common practice, it will be called a non-eligible measure. The characteristics of non-eligible measures identified in para 26 need to be separately calculated and the energy saving from such measures ($\Delta\eta_{nem}$) shall be adjusted accordingly. The adjustment of energy savings due to such measures must be adequately justified to demonstrate its conservativeness in equation 13.

## 8. Baseline emissions

26. The baseline emissions are calculated using the following approach for electricity driven baseline centralized cooling systems:

$$\mathrm{BE_y} = EC_{BL,y} \times EF_{CO2,ELEC,y} \qquad \text{Equation (1)}$$

$BE_y$ = Baseline emissions in year y (tCO2e)

$EC_{BL,y}$ = Energy consumption for the baseline centralized cooling system in year y (MWh)

$EF_{CO2,ELEC,y}$ = Electricity emissions factor (tCO2/MWh). The electricity emission factor in year y shall be calculated in accordance with the CDM TOOL 07 "Tool to calculate the emission factor for an electricity system" however it will be monitored ex-post and cannot be fixed ex-ante under this methodology.

27. If the baseline centralized cooling system uses vapour absorption technology the following approaches shall be applied:

$$\mathrm{BE_y} = BEy, electrical + BEy, thermal \qquad \text{Equation (2)}$$

Where:

$BE_{y,electrical}$ = Baseline emissions from electrical energy in year y (tCO2e)

$BE_{y,thermal}$ = Baseline emissions from thermal energy in year y (tCO2e)

28. For the electrical energy consumption in MWh:

$$\mathrm{BE_{y,electrical}} = EC_{BL,y,electrical} \times EF_{CO2,ELEC,y} \qquad \text{Equation (3)}$$

$BE_y$ = Baseline emissions from electrical energy in year y (tCO2e)

$EC_{BL,y}$ = Electrical Energy consumption for the baseline centralized cooling system in year y (MWh)

$EF_{CO2,ELEC,y}$ = Electricity emissions factor (tCO2/MWh). The electricity emission factor in year y shall be calculated in accordance with

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf/history_view

the CDM TOOL 07 “Tool to calculate the emission factor for an electricity system” however it will be monitored ex-post and cannot be fixed ex-ante under this methodology.

29. For the thermal energy consumption in GJ:

$$\mathrm{BE}_{\mathrm{y,thermal}} = EC_{BL,y,thermal} \times EF_{B,y} \qquad \text{Equation (4)}$$

$BE_{y,thermal}$ = Baseline emissions from thermal energy in year y (tCO2e)

$EC_{BL,y,thermal}$ = Thermal Energy consumption for the baseline centralized cooling system in year y (GJ)

$EF_{B,y}$ = CO2 emission factor of the least carbon intensive energy source used in the baseline or project scenario (tCO2/GJ).

30. The baseline energy consumption $EC_{BL,y}$ for electrical and thermal energy shall be separately calculated for vapour absorption technology following the approaches in subsequent paragraphs.

31. **Case 1:** If the annual average project cooling output ($CAP_{PJ,actual,y}$) is within +/- 15% of the average baseline cooling output ($CAP_{BL,hist}$) calculated over the last 3 years before the project implementation, the quantity of energy consumption of baseline centralized cooling system is determined as follows:

$$EC_{BL,y} = \sum_i \frac{OPC_{i,y}}{SEER_{B,i,y}} \qquad \text{Equation (5)}$$

$EC_{BL,y}$ = Energy consumption for the baseline centralized cooling system in year y (MWh) or (GJ)

$OPC_{i,y}$ = Cooling output of the project centralized cooling plant i in the year y (MWh) or (GJ)

$SEER_{B,i,y}$ = Seasonal Energy Efficiency Ratio of the baseline centralized cooling plant i, (an annual average of last 3 years before the project implementation) defined as energy output divided by energy input (MWh/MWh) or (GJ/GJ)

32. **Case 2:** If the annual average project cooling output is greater than +/- 15% of the average baseline cooling output calculated over the most recent 3 years prior to the project implementation, the quantity of energy consumption of the baseline centralized cooling system is determined as follows:

$$EC_{BL,y} = \sum_i \sum_{h=1}^{h=niy} \frac{OPC_{i,h}}{SEER_{B,i,h}} \qquad \text{Equation (6)}$$

$EC_{BL,y}$ = Energy consumption for the baseline centralized cooling plant i in year y (MWh) or (GJ)

$OPC_{i,h}$ = Cooling output of the project centralized cooling plant i in hour h in the year y (MWh) or (GJ)

$SEER_{B,i,h}$ = Seasonal Energy Efficiency Ratio of the baseline centralized cooling plant i (an hourly average of last 3 years before the

project implementation) defined as energy output divided by energy input (MWh/MWh) or (GJ/GJ)

$n_{i,y}$ = Number of operating hours for the centralized cooling plant i in year y

33. **For case 1,** the Seasonal Energy Efficiency Ratio of the baseline centralized cooling system can be determined using one of the following options:

34. **Option 1:** The average annual Seasonal Energy Efficiency Ratio shall be established based on the historic data of energy output divided by energy input for the most recent three years of operation of the baseline centralized cooling system using the formula:

$$SEER_{B,i,y} = \frac{OPC_{B,i,y}}{IPE_{B,i,y} \times 3.6 + IPT_{B,i,y}} \quad \text{Equation (7)}$$

$SEER_{B,i,y}$ = Average annual Seasonal Energy Efficiency Ratio of the baseline centralized cooling plant i in Case 1 (GJ)/(GJ)

$OPC_{B,i,y}$ = Cooling output of the baseline centralized cooling plant i, an annual average of last 3 years before the project implementation under Case 1 (GJ)

$IPE_{B,i,y}$ = Electrical energy input of baseline centralized cooling plant i, an annual average of last 3 years before the project implementation (MWh)

$IPT_{B,i,y}$ = Thermal energy input of the baseline centralized cooling plant i, an annual average of last 3 years before the project implementation (GJ). This parameter is zero when the baseline centralized cooling plant is electricity driven.

35. **Option 2:** The Seasonal Energy Efficiency Ratio can be established through computer simulation modelling that meets the conditions below:

(a) It has successfully met the analytical verification and empirical validation requirement as defined in scientifically recognized protocols or in a comparable international or national standard (e.g., Arcadia Suite™ [5]or any other applicable regional/global software model); or

(b) It is publicly available and peer-reviewed scientific studies have acknowledged that it successfully simulates the electricity consumption associated with cooling needs of the buildings. The main characteristics of the model and input parameters are available in Annex 1.

36. **For case 2,** the $EC_{BL,y}$ is the sum of the hourly cooling output of the project centralized cooling system divided by the hourly $SEER_{B,i,h}$ of baseline centralized cooling plant corresponding to output delivered by project centralized cooling plant in hour h of year y in similar ambient conditions.

[5] https://arcadia-suite.com/

37. Depending on whether the centralized cooling system includes the cooling towers and cooling water pumps, data for the parameters below needs to be collected.

    (a) **Method 1.** Inlet water temperature to condenser shall be collected for reference, if the project boundary of the cooling system includes a compressor, coolant pumps and heat exchangers and does not include the cooling towers and cooling water pumps.
    (b) **Method 2**. Wet and dry bulb temperature shall be collected for reference, if the project boundary of the cooling system includes the whole system i.e. a compressor, coolant pumps, heat exchangers as well as the cooling towers and cooling water pumps.

38. The hourly Seasonal Energy Efficiency Ratio of the baseline centralized cooling plant can be determined using the following formula:

$$SEER_{B,i,h} = \frac{OPC_{B,i,h}}{IPE_{B,i,h} \times 3.6 + IPT_{B,i,h}} \quad \text{Equation (8)}$$

$SEER_{B,i,h}$ = Hourly Seasonal Energy Efficiency Ratio of the baseline centralized cooling plant i, in case 2 (GJ)/(GJ)

$OPC_{B,i,h}$ = Hourly Cooling output of the project centralized cooling plant i, for the last 3 years before the project implementation (GJ)

$IPE_{B,i,h}$ = Hourly Electrical energy input of the baseline centralized cooling plant i, for the last 3 years before the project implementation (MWh)

$IPT_{B,i,h}$ = Hourly Thermal energy input of the baseline centralized cooling plant i, for the last 3 years before the project implementation (GJ). This parameter is zero when the baseline centralized cooling plant is electricity driven

39. The Thermal energy input of the baseline centralized cooling plant parameter $IPT_{B,i,h}$ is to account for thermal energy input in an absorption-based baseline technology and is determined based on the following approach:

$$IPT_{B,i,h} = FF_{B,i,h} \times NCV_{B,i,h} \times 0.2778 \quad \text{Equation (9)}$$

$IPT_{B,i.h}$ = Hourly Thermal energy input of the baseline centralized cooling plant i (MWh)

$FF_{B,i,h}$ = Hourly Fossil fuel consumption used in the baseline centralized cooling plant i (mass or volume unit)

$NCV_{B,i,h}$ = Net calorific value of the fossil fuel used in the baseline centralized cooling plant i (GJ/mass or volume unit). For a centralized cooling plant where more than one type of fossil fuel is used in the baseline, the least carbon intensive fossil fuel should be used.

40. If the thermal energy input of the baseline centralized cooling system is in GJ then the conversion factor 0.2778 MWh/GJ shall not be used in equation 9.

41. The following steps shall be undertaken to establish $SEER_{B,i,,h}$.

(a) Collect hourly SEER values for the baseline centralized cooling plant for three years prior to implementation of the project activity (e.g. 8760 values per year). For each hourly value of $SEER_{B,i,h}$ , the following parameters shall be collected:

i) The value for cooling output,
ii) Electrical/thermal input and
iii) Method 1: Inlet water temperature to condenser, if the project boundary of the centralized cooling system includes a compressor, coolant pumps and heat exchangers and does not include cooling towers and cooling water pumps;

Method 2. Wet and dry bulb temperature, if the project boundary of the centralized cooling system includes a compressor, coolant pumps, heat exchangers, cooling towers, and cooling water pumps.

(b) If the most recent three-year data before implementation of the project activity is not available for the existing centralized cooling plant particularly for the system that has been commissioned in the last three years. A minimum of one recent year baseline data is required for the calculation of $SEER_{B,i,,h}$ . This $SEER_{B,i,,h}$ data shall be presented in the Excel format or any other suitable tabular format with respect to i) to iii).

| Baseline Period (Date/Hr) | Baseline cooling output (GJ/MWh) i) | Baseline energy Input (GJ/MWh) ii) | Condenser Temp ($^0$C) iii) | Ambient Temp ($^0$C) iii) | | $SEER_{B,i,h}$ |
|---|---|---|---|---|---|---|
| | | | | Dry bulb | Wet bulb | |
| | | | | | | |
| | | | | | | |

(c) During the project year, each hourly value for cooling output, energy input and inlet water temperature to condenser (Method 1) or wet and dry bulb temperature (Method 2) shall be collected.

(d) For each hour h in project year y, select the baseline value of $SEER_{B,i,,h}$ from above table for the corresponding combination of +/-5% of project cooling output and +/-5% of project condenser inlet water temperature (Method 1) or wet and dry bulb temperature (Method 2). Develop an Excel sheet/table of hourly corresponding values of $SEER_{B,i,,h}$.

| Project Period (Date/Hr) | Project cooling output (GJ/MWh) | Project energy Input (GJ/MWh) | Condenser Temp ($^0$C) | Ambient Temp ($^0$C) | | Corresponding $SEER_{B,i,h}$ at (+/-5%) output and (+/-5%) inlet temp from the above table |
|---|---|---|---|---|---|---|
| | | | | Dry bulb | Wet bulb | |
| | | | | | | |
| | | | | | | |

(e) If there is no corresponding value or there are several corresponding values of $SEER_{B,i,,h}$ for baseline centralized cooling plant pertaining to project hourly value of cooling output and condensing water temperature (Method 1) or wet and dry temperature (Method 2), the cell of baseline$SEER_{B,i,h}$ shall be filled in with the highest performance value of the baseline centralized cooling plant.

42. The cooling output of the project centralized cooling system can be determined as follows:

43. **Option 1:** Direct measurement of the cooling energy in MWh

44. **Option 2:** Calculated based on the measurement of the temperature differences of chilled water in and out, flow rate of chilled water and system operating hours per year as follows:

$$OPC_y = \sum_i \sum_{h=1}^{h=n,i,y} C_{P,i} \times F_{P,i,h} \times \Delta T_{i,h} \times 2.77 \times 10^{-10} \quad \text{Equation (10)}$$

$OPC_y$ = Cooling output of the project centralized cooling system in the year y (MWh)

$i$ = Specific heat capacity of the chilled water of the project centralized cooling plant i (J/g $^0$C)

$F_{P,i,h}$ = Average hourly flow of the chilled water in project centralized cooling plant i in year y (g)

$\Delta T_{i,y}$ = Temperature difference between the supply and return of chilled water from/to project centralized cooling plant i in year y ($^0$C)

$n_{i,y}$ = Number of operating hours of the project centralized cooling plant i in year y (hours)

45. The temperature difference between the supply and return of chilled water to/from project centralised cooling plant will be calculated as follows:

$$\Delta T_{i,y} = T_{r,i,y} - T_{s,i,y} \quad \text{Equation (11)}$$

$\Delta T_{i,y}$ = Temperature difference between the supply and return of chilled water to/from~~/to~~ the project centralized cooling plant i in year y ($^0$C)

$T_{r,i,y}$ = Temperature of returned chilled water to the project centralized cooling plant i in year y ($^0$C)

$T_{s,i,y}$ = Temperature of supplied chilled water from the project centralized cooling plant i in year y ($^0$C)

## 9. Project Emissions

46. Project emissions include emissions from energy consumption associated with the generation of cooling output in the centralized cooling system.

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad \text{Equation (12)}$$

$PE_y$ = Project emissions in year y (tCO2e)

$PE_{EC,y}$ = Emissions from electricity consumption associated with the generation of cooling output in the project cooling system (tCO2e)

$PE_{FC,j,y}$ = CO2 emissions from fossil fuel combustion associated with the generation of cooling output in the project centralized cooling system (tCO2e).

47. The project emissions from consumption of electricity by the project activity( $PE_{EC,y}$ ) shall be calculated using the CDM TOOL 05: "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

48. The project emissions from fossil fuel combustion by the project activity $(PE_{FC,j,y})$ shall be calculated using the CDM TOOL 03 "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".

## 11. Leakage Emissions

49. Leakage emissions from the energy use in production of refrigerants are assumed to be zero as these emissions are expected to be the same in project and baseline scenario.

50. If HCFC-22 is used as refrigerant under the project activity and/or in the baseline, then HFC-23 emissions occur as a byproduct from the production of HCFC-22 shall be accounted for leakage emissions, as follows

$$LE_y = \left(Q_{HCFC22,PJ,start} + Q_{HCFC22,PJ,y} - Q_{HCFC22,BL,y}\right) * 0.03 * GWP_{HFC23} \quad \text{Equation (13)}$$

$LE_y$ = Leakage emissions due to production of HFC-23 during manufacturing of HCFC-22 in year y (tCO2e)

$Q_{HCFC22,PJ,start}$ = Quantity of HCFC-22 charge in the new chiller at its start of operation (only accounted in the first year of the first crediting period) (tonnes)

$Q_{HCFC22,PJ,y}$ = Average annual quantity of HCFC-22 used in year y to replace refrigerant that has leaked in year y (tonnes)

$Q_{HCFC22,BL,y}$ = In case the existing chiller also uses the HCFC-22 as refrigerant, $Q_{HCFC22,BL}$ should be estimated for year y based on three year average quantity of HCFC-22 used in the baseline chillers (tonnes)

$GWP_{HFC23}$ = Global Warming Potential of HFC-23 (t CO2e/t HFC23)

51. The used refrigerant from the replaced chiller may add to the leakage emissions depending on its ultimate end.

(a) **Stored or leaked to the atmosphere**: The refrigerant leaked or stored is considered to be emitted to the atmosphere. The emissions shall be calculated based on GWP of HCFC-22 (1810 tCO2e/tHCFC-22) or other refrigerants (as per their global warming potential).

(b) **Recovered and Destroyed**: In case the used refrigerant is incinerated. The equivalent CO2 emissions shall be calculated from the incineration. For example, emissions[6]

[6] GHG emissions from transport to carry refrigerant to destruction facility are considered to be negligible.

from incineration of HCFC-22 (0.5087tCO2/tHCFC-22) and from fossil fuel used for the incineration.

(c) **Sold out and reuse**: If the sale and reuse of the refrigerant is demonstrated with credible evidence, the leakage calculated in para 51 a) may be neglected.

## 12. Emission Reductions

52. Emission reductions from efficiency measures are calculated as follows:

$$ERem_y = BE_y - PE_y - LE_y \quad \text{Equation (14)}$$

$ERem_y$ = Emission reductions due to eligible efficiency measures in year y (tCO2e)

$BE_y$ = Baseline emissions in year y (tCO2e)

$PE_y$ = Project emissions in year y (tCO2e)

$LE_y$ = Leakage emissions in year y (tCO2e)

53. Emission Reductions due to non-eligible efficiency measures

$$\mathrm{ERnem_y} = ES_y \times EF_{CO2e,y} \quad \text{Equation (15)}$$

$ERnem_y$ = Emission reductions due to non-eligible efficiency measures in year y (tCO2e)

$ES_y$ = Energy Savings conservatively estimated due to non-eligible energy efficiency measures identified in para 26 (MWh or GJ)

$EF_{CO2e,y}$ = Emissions factor (tCO2e/MWh or tCO2e/GJ).
i) The electricity emission factor (tCO2e/MWh) in year y shall be calculated in accordance with the CDM TOOL 07 “Tool to calculate the emission factor for an electricity system” however it will be monitored ex-post and cannot be fixed ex-ante under this methodology.
ii) The thermal emission factor (tCO2e/GJ) of the least carbon intensive energy source used in the baseline or project scenario

Where,

$$ES_y = \Delta\eta\mathrm{nem}_y \times EC_y \quad \text{Equation (16)}$$

$ES_y$ = Energy Savings estimated due to non-eligible energy efficiency measures identified in para 27 (MWh or GJ)

$\Delta\eta\mathrm{nem}_y$ = Increase in energy efficiency of the equipment due to non-eligible energy efficiency measures (MWh/MWh or GJ/GJ)

$EC_y$ = Energy Consumption by the centralized cooling system in year y (MWh or GJ)

54. Emission reductions due to switch of the energy source (fuel switch) from a carbon-intensive to a less carbon-intensive one is calculated according to another applicable approved methodology.

55. Total emission reductions are calculated as follows:

$$ER_y = ERem_y + ERes_y - ERnem_y \quad \text{Equation (17)}$$

$ER_y$ = Total Emission reductions in year y (tCO2e)

$ERem_y$ = Emission reductions due to efficiency measures in year y (tCO2e)

$ERes_y$ = Emission reductions due to change in energy source (fuel switch) in year y (tCO2e)

$ERnem_y$ = Emission reductions due to non-eligible efficiency measures in year y (tCO2e)

56. If the project results in negative emission reductions in a particular monitoring period, ACCs will only be issued when the emissions increase has been compensated by subsequent emission reductions by the project activity.

# 13. Monitoring Methodology

57. All the assumptions made related to monitoring parameters should be explained and documented transparently in the project submission to GCC.

## 13.1 Parameters <u>not</u> monitored during the crediting period

58. In addition to the data and parameters listed below, the guidance on "Data and parameters not monitored" in all tools to which this methodology refers/applies.

**Data / Parameter Table 1.1**

| **Data / Parameter:** | $C_p$ |
|---|---|
| Data unit: | J/g $^0$C |
| Description: | Specific heat capacity of coolant |
| Source of data: | Coolant provider |
| Measurement procedures (if any): | - |
| Quality Procedure, if any: | - |
| Any comment: | |

**Data / Parameter Table 1.2**

| **Data / Parameter:** | $T_{B,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Condenser inlet water temperature of baseline centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Once at ~~in~~ the beginning of crediting period based on 3 years data. |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 1.3**

| **Data / Parameter:** | $Twet\ bulb_{B,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Wet bulb temperature of baseline centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Once at the beginning of crediting period based on 3 years data. |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 1.4**

| **Data / Parameter:** | $Tdry\ bulb_{B,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Dry bulb temperature of baseline centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Once at the beginning of crediting period based on 3 years data. |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 1.5**

| **Data / Parameter:** | $OPC_{B,i,y}$ |
|---|---|
| Data unit: | MWh or GJ |
| Description: | Cooling output of baseline centralized cooling plant i |
| Source of data | Meters (Temperature and flow) |
| Measurement procedures (if any): | Based on direct simultaneous measurements of: Differential temperature of supply and return chilled water, and Chilled water flow |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if option 1 is chosen to determine the value of SEER for the baseline centralized cooling plant. |

**Data / Parameter Table 1.6**

| **Data / Parameter:** | $IPE_{B,i,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electrical energy input of the baseline centralized cooling plant i |
| Source of data | Electricity Meter |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |

| | |
|---|---|
| Quality Procedures, if any. | Meters shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if option 1 is chosen to determine the value of SEER for the baseline centralized cooling plant |

**Data / Parameter Table 1.7**

| **Data / Parameter:** | $IPT_{B,i,y}$ |
|---|---|
| Data unit: | GJ |
| Description: | Thermal energy input of the baseline centralized cooling plant i |
| Source of data | Appropriate Meter to quantify thermal energy (e.g. flow meter and temperature meters) |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Meters shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if option 1 is chosen to determine the value of SEER for the baseline centralized cooling plant |

**Data / Parameter Table 1.7**

| **Data / Parameter:** | $OPC_{B,i,h}$ |
|---|---|
| Data unit: | MWh or GJ |
| Description: | Cooling output of baseline centralized cooling plant i in hour h |
| Source of data | Meters (Temperature and flow) |
| Measurement procedures (if any): | Based on direct simultaneous measurements of: Differential temperature of supply and return chilled water, and Chilled water flow |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Meters shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if Case 2 is chosen to determine the value of SEER for the baseline centralized cooling plant |

**Data / Parameter Table 1.8**

| **Data / Parameter:** | $IPE_{B,i,h}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electrical energy input of the baseline centralized cooling plant i in hour h |
| Source of data | Electricity Meter |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Meters shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if Case 2 is chosen to determine the value of SEER for the baseline centralized cooling plant |

**Data / Parameter Table 1.9**

| **Data / Parameter:** | $IPT_{B,i,h}$ |
|---|---|
| Data unit: | GJ |
| Description: | Thermal energy input of the baseline centralized cooling plant i in hour h |
| Source of data | Appropriate Meter to quantify thermal energy (e.g. flow meter and temperature meters) |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | Meters shall be subject to regular maintenance and calibrations in order to ensure measurements with low uncertainty. 3 years data is to be stored electronically once at the beginning of crediting period. |
| Any comment: | These requirements apply if Case 2 is chosen to determine the value of SEER for the baseline centralized cooling plant |

**Data / Parameter Table 1.10**

| **Data / Parameter:** | $EF_{B,y}$ |
|---|---|
| Data unit: | tCO2e/GJ |
| Description: | CO2 emission factor of the least carbon intensive energy source used in the absorption centralized cooling system during the most recent 3 years before project implementation |
| Source of data | The following data sources may be used if the relevant conditions apply: |

| Data source | Conditions for using the data source |
|---|---|
| (a) Values provided by the fuel supplier in invoices | This is the preferred source |
| (b) Measurements by the project participants | If (a) is not available |
| (c) Regional or national default values | If (a) and (b) are not available. These values can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances) |
| (d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories | If above are not available |

| | |
|---|---|
| Measurement procedures (if any): | For (a) and (b): Measurements should be undertaken in line with national or international fuel standards |
| Monitoring frequency: | Yearly |

**Data / Parameter Table 1.11**

| **Data / Parameter:** | $FF_{B,i,h}$ |
|---|---|
| Data unit: | Mass or volume units |
| Description: | Amount of Fossil fuel consumption used in the baseline in centralized cooling plant i in hour h, prior to the implementation of the project activity |
| Source of data | Measured data for most recent 3 years |

| | |
|---|---|
| Measurement procedures (if any): | 1.Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift);<br>2. Accessories such as transducers, sonar and piezoelectric devices are accepted if they are properly calibrated with the ruler gauge and receive a reasonable maintenance;<br>3. For liquid fuel consumption directly from a storage tank, in case of a daily gauge measurement of storage tanks with pre-heaters for heavy oil, the calibration will be made with the plant at typical operational conditions |
| Monitoring frequency: | Continuous, recorded hourly |
| Quality Procedures, if any. | The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes |
| Any comment: | |

**Data / Parameter Table 1.12**

| | |
|---|---|
| Data / Parameter: | $NCV_{B,i,h}$ |
| Data unit: | GJ/mass or volume unit |
| Description: | Net calorific value of the baseline fossil fuel used in centralized cooling plant i in hour h |
| Source of data | The following data sources may be used if the relevant conditions apply: |

| Data source | Conditions for using the data source |
|---|---|
| (a) Values provided by the fuel supplier in invoices | This is the preferred source if the carbon fraction of the fuel is not provided. |
| (b) Measurements by the project participants | If (a) is not available |
| (c) Regional or national default values | If (a) and (b) are not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances) |
| (d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories | If above are not available |

| | |
|---|---|
| Measurement procedures (if any): | For (a) and (b): Measurements should be undertaken in line with national or international fuel standards |
| Monitoring frequency: | For (a) and (b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For (c): Review appropriateness of the values annually. For (d): Any future revision of the IPCC Guidelines should be taken into account. |
| Quality Procedures, if any. | Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome |

| | |
|---|---|
| | or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards |
| Any comment: | |

**Data / Parameter Table 1.13**

| **Data / Parameter:** | $Q_{HCFC22,BL,y}$ |
|---|---|
| Data unit: | t |
| Description: | Quantity of refrigerant used in the baseline cooling system during operational phase |
| Source of data | Project owners' data logs, most recent 3 years consumption data |
| Measurement procedures (if any): | Plant records |
| Monitoring frequency: | Yearly |
| Quality Procedures, if any. | |
| Any comment: | |

**Data / Parameter Table 1.14**

| **Data / Parameter:** | $Incineration\ Emissions\ (IE_{HCFC22})$ |
|---|---|
| Data unit: | $tCO_2$/ tHCFC-22 |
| Description: | Conversion factor expressing the amount of $CO_2$ generated per amount of HCFC-22 decomposed/incinerated |
| Source of data | Molecular weight balance of the chemical process of conversion of HCFC-22 into $CO_2$ |
| Value to be applied | 0.50867 |
| Monitoring frequency: | Not applicable |
| Quality Procedures, if any. | - |
| Any comment: | |

**Data / Parameter table 1.15**

| **Data / Parameter:** | $GWP_{HCFC22}$ |
|---|---|
| Data unit: | tCO2e/ tHCFC22 |
| Description: | Global Warming Potential for refrigerant for 100-year time horizon |
| Source of data | IPCC |
| Measurement procedures (if any): | - |
| Monitoring frequency: | Not applicable |
| Quality Procedures, if any. | Latest published IPCC data |
| Any comment: | |

**Data / Parameter Table 1.16**

| **Data / Parameter:** | $GWP_{HFC23}$ |
|---|---|
| Data unit: | tCO2e/ tHFC-23 |

| | |
|---|---|
| Description: | Global Warming Potential for byproduct of refrigerant for 100-year time horizon |
| Source of data | IPCC |
| Measurement procedures (if any): | - |
| Monitoring frequency: | Not applicable |
| Quality Procedures, if any. | Latest published IPCC data |
| Any comment: | |

**Data / Parameter Table 1.17**

| **Data / Parameter:** | **Remaining lifetime of the existing equipment** |
|---|---|
| Data unit: | Years |
| Description: | Time when the existing equipment would need to be replaced in the absence of the project activity |
| Source of data | Project Activity |
| Measurement procedures (if any): | Determined as described in the Tool 10: Tool to determine the remaining lifetime of equipment" |
| Monitoring frequency: | At the time of validation |
| Any comment: | - |

**Data / Parameter Table 1.18**

| **Data / Parameter:** | $\Delta\eta_{nem}$ |
|---|---|
| Data unit: | Non-dimensional |
| Description: | Energy efficiency improvement resulting from non-eligible measures implemented jointly with the proposed project activity |
| Source of data | Project site |
| Measurement procedures (if any): | Estimate the impact of energy efficiency improvement resulting from non-eligible measures implemented jointly with the proposed project activity using recognized standards and engineering best practices |
| Monitoring frequency: | Once at the time of validation |
| Any comment: | - |

**Data / Parameter Table 1.19**

| **Data / Parameter:** | $\mathbf{CAP_{BL,design}}$ |
|---|---|
| Data unit: | TR[7] |
| Description: | Design cooling generation capacity of the baseline centralised cooling system, as per design conditions, previous to the implementation of the project activity |
| Source of data | Project activity site |
| Measurement procedures (if any): | This shall be based on commissioning certificate of the cooling plant, as issued by the supplier or implementing entity |
| Monitoring frequency: | At the time of validation |
| Any comment: | - |

[7] Tons of Refrigeration

**Data / Parameter Table 1.20**

| **Data / Parameter:** | **$CAP_{BL,hist}$** |
|---|---|
| Data unit: | TR |
| Description: | Average annual cooling generation of the baseline centralised cooling system prior to the implementation of the project activity based on most recent 3 years data |
| Source of data | Plant records |
| Measurement procedures (if any): | Measurement of chilled water flow, inlet/outlet temperature and specific heat in the most recent 3 years prior to the implementation of the project activity |
| Monitoring frequency: | At the time of validation |
| Any comment: | - |

## 13.2 Parameters to be monitored during the crediting period

**Data / Parameter Table 2.1**

| Data / Parameter: | $OPC_{i,y}$ |
|---|---|
| Data unit: | MWh or GJ |
| Description: | Cooling output of project centralized cooling plant i in year y |
| Source of data | Calculated based on equation 9 |
| Measurement procedures (if any): | Measurement procedures of parameters included in Equation (9) as specified in this section (i.e. section 13.2) |
| Monitoring frequency: | Monitoring frequency of parameters included in Equation (9) as specified in this section (i.e. section 13.2) |
| Quality Procedures, if any. | QA/QC procedures of parameters included in Equation (9) as specified in this section (i.e. section 13.2) |
| Any comment: | This parameter is to be monitored if the option 1 is chosen to determine the cooling output of the project centralized cooling plant |

**Data / Parameter Table 2.2**

| **Data / Parameter:** | $T_{s,i,y}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Temperature of supplied chilled water from the project centralized cooling plant i in year y |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard Data is to be stored electronically |
| Any comment: | This parameter must be monitored if the option 2 is chosen to determine the cooling output of the project centralized cooling plant |

**Data / Parameter Table 2.3**

| **Data / Parameter:** | $T_{r,i,y}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Temperature of returned chilled water to the project centralized cooling plant i in year y |

| | |
|---|---|
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard Data is to be stored electronically |
| Any comment: | This parameter must be monitored if the option 2 is chosen to determine the cooling output of the project centralized cooling plant |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard Data is to be stored electronically |
| Any comment: | This parameter must be monitored if the option 2 is chosen to determine the cooling output of the project centralized cooling plant |

**Data / Parameter Table 2.4**

| **Data / Parameter:** | $n_{i,y}$ |
|---|---|
| Data unit: | hours |
| Description: | Number of the operating hours of the project centralized cooling plant i in year y |
| Source of data | Plant records |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | |
| Any comment: | This parameter shall be monitored if the option 2 is chosen to determine the cooling output of the project centralized cooling plant |

**Data / Parameter Table 2.5**

| **Data / Parameter:** | $T_{P,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Condenser inlet water temperature of project centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard. Data is to be stored electronically |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 2.6**

| **Data / Parameter:** | $Twet\ bulb_{P,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Wet bulb temperature of project centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |

| | |
|---|---|
| Quality Procedures, if any. | Meter is subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard. Data is to be stored electronically |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 2.7**

| **Data / Parameter:** | $Tdry\ bulb_{P,i,h}$ |
|---|---|
| Data unit: | $^0$C |
| Description: | Dry bulb temperature of project centralized cooling plant i in hour h |
| Source of data | Thermometers |
| Measurement procedures (if any): | |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | Meter is subject to regular maintenance and calibrations in accordance with the requirements of the GCC Project Standard. Data is to be stored electronically |
| Any comment: | This parameter is required if Case 2 is applicable |

**Data / Parameter Table 2.8**

| **Data / Parameter:** | $FF_{P,i,y}$ |
|---|---|
| Data unit: | Mass or volume units |
| Description: | Average mass flow rate (integrated over the year) of project centralized cooling plant i in year y |
| Source of data | On-site measurements |
| Measurement procedures (if any): | 1.Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift);<br>2. Accessories such as transducers, sonar and piezoelectric devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance;<br><br>3. For liquid fuel consumption directly from a storage tank, in the case of a daily gauge measurement of storage tanks with pre-heaters for heavy oil, the calibration will be made with the plant at typical operational conditions |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | Meter shall be subject to regular maintenance and calibrations in order to ensure measurements with low degree of uncertainty. Data is to be stored electronically |
| Any comment: | The consistency of metered fuel consumption quantities should be crosschecked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the project, the metered fuel consumption quantities should also be crosschecked with available purchase invoices from the financial records |

**Data / Parameter Table 2.9**

| **Data / Parameter:** | $FF_{P,i,h}$ |
|---|---|
| Data unit: | Mass or volume units |
| Description: | Fossil fuel consumption used in the centralized cooling plant i, in hour h |

| | |
|---|---|
| Source of data | Measured data |
| Measurement procedures (if any): | Mass or volume meters |
| Monitoring frequency: | Continuous, hourly recorded |
| Quality Procedures, if any. | The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes |
| Any comment: | |

**Data / Parameter Table 2.10**

| | |
|---|---|
| **Data / Parameter:** | $EF_{P,y}$ |
| Data unit: | tCO2e/GJ |
| Description: | CO2 emission factor of the least carbon intensive energy source used in the absorption centralized cooling system in year y |
| Source of data | The following data sources may be used if the relevant conditions apply: |
| Measurement procedures (if any): | For (a) and (b): Measurements should be undertaken in line with national or international fuel standards |
| Monitoring frequency: | Yearly |
| Quality Procedures, if any. | For a) and b): The CO2 emission factor shall be obtained for each fuel delivery, from which weighted average annual values should be calculated. For c): Review appropriateness of the values annually; For d): Any future revision of the IPCC Guidelines should be taken into account |
| Any comment: | |

| Data source | Conditions for using the data source |
|---|---|
| (a) Values provided by the fuel supplier in invoices | This is the preferred source if the carbon fraction of the fuel is not provided. |
| (b) Measurements by the project participants | If (a) is not available |
| (c) Regional or national default values | If (a) and (b) are not available. These values can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances) |
| (d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories | If above are not available |

**Data / Parameter table 2.11**

| | |
|---|---|
| **Data / Parameter:** | $NCV_{P,i,y}$ |
| Data unit: | GJ/mass or volume unit |
| Description: | Net calorific value of the fossil fuel used in centralized cooling plant i, year y |
| Source of data | The following data sources may be used if the relevant conditions apply: |

| | |
|---|---|
| | <table><tr><td>Data source</td><td>Conditions for using the data source</td></tr><tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr><tr><td>(b) Measurements by the project participants</td><td>If (a) is not available</td></tr><tr><td>(c) Regional or national default values</td><td>If (a) and (b) are not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)</td></tr><tr><td>(d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If above are not available</td></tr></table> |
| Measurement procedures (if any): | For (a) and (b): Measurements should be undertaken in line with national or international fuel standards |
| Monitoring frequency: | For (a) and (b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For (c): Review appropriateness of the values annually. For (d): Any future revision of the IPCC Guidelines should be taken into account. |
| Quality Procedures, if any. | Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards |
| Any comment: | |

**Data / Parameter Table 2.12**

| **Data / Parameter:** | $EF_{CO2,ELEC,y}$ |
|---|---|
| Data unit: | tCO2e/MWh |
| Description: | CO2 emission factor of the grid electricity in year y |
| Source of data | National grid data |
| Measurement procedures (if any): | Combined margin CO2 emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”; |
| Monitoring frequency: | The emission factor will be calculated as per “Tool to calculate the emission factor for an electricity system” however it will be monitored ex-post and cannot be fixed ex-ante under this methodology. |
| Quality Procedures, if any. | - |
| Any comment: | - |

**Data / Parameter Table 2.13**

| **Data / Parameter:** | $n_{scrapped}$ |
|---|---|
| Data unit: | Number |
| Description: | Number of scrapped baseline chillers or other equipment |
| Source of data | Project owners’ data logs |

| | |
|---|---|
| Measurement procedures (if any): | |
| Monitoring frequency: | |
| Quality Procedures, if any. | Compare the number of baseline equipment replaced and number of equipment scrapped to ensure compliance with the applicability of the methodology. The scrapped equipment cannot be re-used in another plant. |
| Any comment: | |

**Data / Parameter Table 2.14**

| **Data / Parameter:** | $Q_{stored/destroyed}$ |
|---|---|
| Data unit: | t |
| Description: | Quantity of refrigerant stored and destroyed from the baseline chillers that are scrapped as a result of the project activity |
| Source of data | Project owners' data logs |
| Measurement procedures (if any): | |
| Monitoring frequency: | Once for the first year of the crediting period if destroyed.<br>Yearly if stored and not destroyed |
| Quality Procedures, if any. | |
| Any comment: | |

**Data / Parameter Table 2.15**

| **Data / Parameter:** | $Q_{HCFC22,PJ,start}$ |
|---|---|
| Data unit: | t |
| Description: | Quantity of refrigerant used in new chillers at the time of commissioning of the project activity |
| Source of data | Project owners' data logs |
| Measurement procedures (if any): | |
| Monitoring frequency: | Once for the first year of the crediting period |
| Quality Procedures, if any. | |
| Any comment: | |

**Data / Parameter Table 2.16**

| **Data / Parameter:** | $Q_{HCFC22,PJ,y}$ |
|---|---|
| Data unit: | t |
| Description: | Quantity of refrigerant used in the project activity during operation phase |
| Source of data | Project owners' data logs |
| Measurement procedures (if any): | |
| Monitoring frequency: | Yearly |
| Quality Procedures, if any. | |
| Any comment: | |

**Data / Parameter Table 2.17**

| **Data / Parameter:** | **$CAP_{PJ,design,y}$** |
|---|---|
| Data unit: | TR |
| Description: | Installed annual cooling generation capacity of the project centralised cooling system in year y |
| Source of data | Plant records |
| Measurement procedures (if any): | This parameter has to be monitored every year y throughout the crediting period using internationally approved standards or equivalent national standards.<br>To comply with the applicability conditions, the following condition shall be verified every year y of the crediting period:<br>$CAP_{PJ,design,y} \leq 1.05\ CAP_{BL,design}$<br>The emissions reductions of the project activity shall be made zero from the point in time when the condition above is no longer true |
| Monitoring frequency: | Yearly |
| Any comment: | - |

**Data / Parameter Table 2.18**

| **Data / Parameter:** | **$CAP_{PJ,actual,y}$** |
|---|---|
| Data unit: | TR |
| Description: | Average annual cooling generation of the project centralised cooling system in year y |
| Source of data | Plant records |
| Measurement procedures (if any): | Measurement of chilled water flow, inlet/outlet temperature and specific heat in year y |
| Monitoring frequency: | Yearly |
| Any comment: | - |

# Annex 1

Arcadia Suite[8]

[8] The introduction to Arcadia Suite is attached as a separate document.

| DOCUMENT HISTORY | | |
|---|---|---|
| **Version** | **Date** | **Comment** |
| **V 1.0** | 15/01/2025 | Initial adoption by GCC Steering Committee based on following:<br>i. Consideration by individual steering committee member, followed by evaluation of entire steering committee<br>ii. 30-day global stakeholder consultation taken place between 28/11/2024 to 27/12/2024 |