Bilateral Offset Credit Mechanism Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

<table>
<thead>
<tr>
<th>Host Country</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the methodology proponents submitting this form</td>
<td>Nippon Koei Co., Ltd.</td>
</tr>
<tr>
<td>Sectoral scope(s) to which the Proposed Methodology applies</td>
<td>3. Energy demand</td>
</tr>
<tr>
<td>Title of the proposed methodology, and version number</td>
<td>Energy Saving by Introduction of High Efficiency Centrifugal Chiller, ver01.0</td>
</tr>
</tbody>
</table>
| List of documents to be attached to this form (please check): | ☑ The attached draft BOCM-PDD:  
  ☑ Additional information |
| Date of completion | 27/01/2016 |

History of the proposed methodology

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Contents revised</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>27/01/2016</td>
<td>First edition</td>
</tr>
</tbody>
</table>


A. Title of the methodology

Energy Saving by Introduction of High Efficiency Centrifugal Chiller, Version 1.0

B. Terms and definitions

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifugal chiller</td>
<td>A centrifugal chiller is a chiller applying a centrifugal compressor. It is commonly used for air-conditioning with huge cooling load, e.g., buildings, shopping malls or factories etc.</td>
</tr>
<tr>
<td>Cooling capacity</td>
<td>Cooling capacity is the ability of individual chiller to remove heat. In this methodology, “cooling capacity” is used to represent a cooling capacity per one chiller unit and not for a system with multiple chiller units.</td>
</tr>
<tr>
<td>Periodical check</td>
<td>Periodical check is a periodical investigation of chiller done by manufacturer or agent who is authorized by the manufacturer, in order to maintain chiller performance.</td>
</tr>
</tbody>
</table>

C. Summary of the methodology

<table>
<thead>
<tr>
<th>Items</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHG emission reduction measures</td>
<td>This methodology applies to the project that aims for saving energy by introducing high efficiency centrifugal chiller for the target factory, commerce facilities etc. in Bangladesh.</td>
</tr>
<tr>
<td>Calculation of reference emissions</td>
<td>Reference emissions are GHG emissions from using reference chiller, calculated with power consumption of project chiller, ratio of COPs (Coefficient Of Performance) of reference/project chillers and CO₂ emission factor for electricity consumed.</td>
</tr>
<tr>
<td>Calculation of project emissions</td>
<td>Project emissions are GHG emissions from using project chiller, calculated with power consumption of project chiller and CO₂ emission factor for electricity consumed.</td>
</tr>
<tr>
<td>Monitoring parameter</td>
<td>• Power consumption of project chiller  &lt;br&gt;• Amount of fuel consumed and amount of electricity</td>
</tr>
</tbody>
</table>
D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Criterion 1** | Project chiller is a centrifugal chiller with a capacity of less than 1,150 USRt.  
* 1 USRt = 3.52 kW |
| **Criterion 2** | COP for project chiller \( i \) calculated under the standardizing temperature conditions* (COP_{\text{PJ,tc,i}}) is more than 6.0.  
COP_{\text{PJ,tc,i}} is a recalculation of COP of project chiller \( i \) (COP_{\text{PJ,i}}) adjusting temperature conditions from the project specific condition to the standardizing conditions. COP_{\text{PJ,i}} is derived in specifications prepared for the quotation or factory acceptance test data at the time of shipment by manufacturer.

\[
\text{COP}_{\text{PJ,tc,i}} = \text{COP}_{\text{PJ,i}} \times \frac{\left( T_{\text{cooling-out,i}} - T_{\text{chilled-out,i}} + \text{TD}_{\text{chilled}} + \text{TD}_{\text{cooling}} \right)}{\left( 37 - 7 + \text{TD}_{\text{chilled}} + \text{TD}_{\text{cooling}} \right)}
\]

\( \text{COP}_{\text{PJ,tc,i}} \): COP of project chiller \( i \) calculated under the standardizing temperature conditions* [-]  
\( \text{COP}_{\text{PJ,i}} \): COP of project chiller \( i \) under the project specific conditions [-]  
\( T_{\text{cooling-out,i}} \): Output cooling water temperature of project chiller \( i \) set under the project specific condition [degree Celsius]  
\( T_{\text{chilled-out,i}} \): Output chilled water temperature of project chiller \( i \) set under the project specific condition [degree Celsius]  
\( \text{TD}_{\text{cooling}} \): Temperature difference between condensing temperature of refrigerant and output cooling water temperature  
1.5 degree Celsius set as a default value [degree Celsius]  
\( \text{TD}_{\text{chilled}} \): Temperature difference between evaporating temperature of refrigerant and output chilled water temperature,  
1.5 degree Celsius set as a default value [degree Celsius]  

*The standardizing temperature conditions to calculate COP_{\text{PJ,tc,i}}

- **Chilled water:**  
  * output: 7 degree Celsius  
  * input: 12 degree Celsius

- **Cooling water:**  
  * output: 37 degree Celsius  
  * input: 32 degree Celsius

<p>| <strong>Criterion 3</strong> | Periodical check is conducted at least twice a year. |</p>
<table>
<thead>
<tr>
<th>Criterion 4</th>
<th>Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 5</td>
<td>A plan for not releasing refrigerant used for project chiller is prepared. In the case of replacing the existing chiller with the project chiller, a plan is prepared in which refrigerant used in the existing chiller is not released to the air e.g. re-use of the refrigerant. Execution of the prevention plan is checked at the time of verification, in order to confirm that refrigerant used for the existing one replaced by the project is not released to the air.</td>
</tr>
</tbody>
</table>

### E. Emission Sources and GHG types

<table>
<thead>
<tr>
<th>Reference emissions</th>
<th>Emission sources</th>
<th>GHG types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption by reference chiller</td>
<td>CO₂</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project emissions</th>
<th>Emission sources</th>
<th>GHG types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption by project chiller</td>
<td>CO₂</td>
<td></td>
</tr>
</tbody>
</table>

### F. Establishment and calculation of reference emissions

#### F.1. Establishment of reference emissions

Reference emissions are calculated by multiplying power consumption of project chiller, ratio of COPs for reference/project chillers, and CO₂ emission factor for electricity consumed.

The COP of reference chiller is conservatively set as a default value in the following manner to ensure the net emission reductions.

1. The COP value tends to increase as the cooling capacity becomes larger.
2. The reference COP, which has a certain cooling capacity, is set at a maximum value in corresponding cooling capacity range.
3. The maximum values of COP in each cooling capacity ranges are defined as COP_{RE,i} as described in Section I.

#### F.2. Calculation of reference emissions
**G. Calculation of project emissions**

\[
RE_p = \sum_i \left( EC_{P,i,p} \times \left( COP_{P,i,c} \div COP_{RE,i} \right) \times EF_{elec} \right)
\]

- \(RE_p\): Reference emissions during the period \(p\) [tCO\(_2\)/p]
- \(EC_{P,i,p}\): Power consumption of project chiller \(i\) during the period \(p\) [MWh/p]
- \(COP_{P,i,c}\): COP of project chiller \(i\) calculated under the standardizing temperature conditions [-]
- \(COP_{RE,i}\): COP of reference chiller \(i\) under the standardizing temperature conditions [-]
- \(EF_{elec}\): CO\(_2\) emission factor for consumed electricity [tCO\(_2\)/MWh]

**H. Calculation of emissions reductions**

\[
ER_p = RE_p - PE_p
\]

- \(ER_p\): Emission reductions during the period \(p\) [tCO\(_2\)/p]
- \(RE_p\): Reference emissions during the period \(p\) [tCO\(_2\)/p]
- \(PE_p\): Project emissions during the period \(p\) [tCO\(_2\)/p]

**I. Data and parameters fixed \textit{ex ante}**

The source of each data and parameter fixed \textit{ex ante} is listed as below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(EF_{elec})</td>
<td>CO(_2) emission factor for consumed electricity [tCO(_2)/MWh].</td>
<td>[Grid electricity]</td>
</tr>
<tr>
<td></td>
<td>When project chiller consumes only grid electricity or captive electricity, the project participant applies the CO(_2) emission factor</td>
<td>The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced</td>
</tr>
</tbody>
</table>
respectively. When project chiller may consume both grid electricity and captive electricity, the project participant applies the CO$_2$ emission factor with lower value.

[CO$_2$ emission factor]
For grid electricity: The most recent value available from the source stated in this table at the time of validation

For captive electricity, it is determined based on the following options:

a) 0.8*
*The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.

b) Calculated from its power generation efficiency ($\eta_{elec} [%]$) obtained from manufacturer’s specification
The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer’s specification is applied;

$$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$$

c) Calculated from measured data
The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{pj,p}$) and the amount of electricity generated ($EG_{pj,p}$) during the monitoring period $p$ is applied. The measurement is conducted with the monitoring equipment to which calibration from “Grid Emission Factor (GEF) of Bangladesh”, endorsed by National CDM Committee unless otherwise instructed by the Joint Committee.

[Captive electricity]
For the option a)
CDM approved small scale methodology: AMS-I.A

For the option b)
Specification of the captive power generation system provided by the manufacturer ($\eta_{elec} [%]$).
CO$_2$ emission factor of the fossil fuel type used in the captive power generation system ($EF_{fuel [tCO_2/GJ]}$)

For the option c)
Generated and supplied electricity by the captive power generation system ($EG_{pj,p} [MWh/p]$).
Fuel amount consumed by the captive power generation system ($FC_{pj,p}$ [mass or weight/p]).
Net calorific value and ($NCV_{fuel} [GJ/mass or weight]$)
CO$_2$ emission factor of the fuel ($EF_{fuel [tCO2/GJ]}$) in order of preference:
1) values provided by the fuel
The COP of the reference chiller $i$ is selected from the default COP value in the following table in line with cooling capacity of the project chiller $i$.

$$\text{COP}_{\text{RE},i} = \frac{1}{\text{EG}_{p,i}}$$

Where:

$N_{CV_{fuel}}$: Net calorific value of consumed fuel [GJ/mass or weight]

The default COP value is derived from the result of survey on COP of chillers from manufacturers that has high market share. The survey should prove the use of clear methodology. The COP$_{\text{RE},i}$ should be revised if necessary from survey result which is conducted by JC or project participants.

<table>
<thead>
<tr>
<th>Cooling capacity /unit (USRt)</th>
<th>$x&lt;300$</th>
<th>$300 \leq x&lt;700$</th>
<th>$700 \leq x&lt;1,150$</th>
</tr>
</thead>
<tbody>
<tr>
<td>COP$_{\text{RE},i}$</td>
<td>5.13</td>
<td>5.50</td>
<td>5.66</td>
</tr>
</tbody>
</table>

Specifications of project chiller $i$ prepared for the quotation or factory acceptance test data by manufacturer.

- **COP$_{\text{PJ},i}$**: The COP of project chiller $i$ under the project specific condition.

- **$T_{\text{cooling-out,}i}$**: Output cooling water temperature of project chiller $i$ set under the project specific condition.

- **$T_{\text{chilled-out,}i}$**: Output chilled water temperature of project chiller $i$ set under the project specific condition.