Joint Crediting Mechanism Approved Methodology ID AM002

"Energy Saving by Introduction of High Efficiency Centrifugal Chiller"

A. Title of the methodology

Energy Saving by Introduction of High Efficiency Centrifugal Chiller

B. Terms and definitions

Terms	Definitions
Centrifugal chiller	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.
Cooling capacity	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.
Periodical check	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.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	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 Indonesia.
Calculation of reference emissions	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 CO_2 emission factor for electricity consumed.
Calculation of project emissions	Project emissions are GHG emissions from using project chiller, calculated with power consumption of project chiller and CO_2 emission factor for electricity consumed.

Monitoring parameter	● Power consumption of project chiller ● Electricity imported from the grid, where applicable ● Operating time of captive electricity generator, where applicable

D. Eligibility criteria

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

Criterion 1	Project chiller is a centrifugal chiller with a capacity of less than 1,250 USRt. * 1 USRt = 3.52 kW
Criterion 2	COP for project chiller *i* calculated under the standardizing temperature conditions* ($COP_{PJ,tc,i}$) is more than 6.0. $COP_{PJ,tc,i}$ is a recalculation of COP of project chiller i ($COP_{PJ,i}$) adjusting temperature conditions from the project specific condition to the standardizing conditions. $COP_{PJ,i}$ is derived in specifications prepared for the quotation or factory acceptance test data at the time of shipment by manufacturer. [equation to calculate $COP_{PJ,tc,i}$] $$\mathbf{COP_{PJ,tc,i}} = \mathbf{COP_{PJ,i}} \times [(\mathbf{T_{cooling-out,i}} - \mathbf{T_{chilled-out,i}} + \mathbf{TD_{chilled}} + \mathbf{TD_{cooling}}) \div (\mathbf{37 - 7 + TD_{chilled} + TD_{cooling}})]$$ $COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions* [-] $COP_{PJ,i}$: COP of project chiller *i* under the project specific conditions [-] $T_{cooling-out,i}$: Output cooling water temperature of project chiller *i* set under the project specific condition [degree Celsius] $T_{chilled-out,i}$: Output chilled water temperature of project chiller *i* set under the project specific condition [degree Celsius] $TD_{cooling}$: Temperature difference between condensing temperature of refrigerant and output cooling water temperature 1.5 degree Celsius set as a default value [degree Celsius] $TD_{chilled}$: 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 $COP_{PJ,tc,i}$ Chilled water: output 7 degree Celsius input 12 degree Celsius

	Cooling water: output 37 degree Celsius input 32 degree Celsius
Criterion 3	Periodical check is planned more than four (4) times annually.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.
Criterion 5	Plan for not releasing refrigerant used for project chiller is prepared. In the case of replacing the existing chiller with the project chiller, refrigerant used for the existing chiller is not released to the air.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Power consumption by reference chiller	CO_2
Project emissions	
Emission sources	GHG types
Power consumption by project chiller	CO_2

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 CO_2 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

$$\mathbf{RE_p} = \sum_{\mathbf{i}} \left\{ \mathbf{EC_{PJ,i,p}} \times \left(\mathbf{COP_{PJ,tc,i}} \div \mathbf{COP_{RE,i}} \right) \times \mathbf{EF_{elec}} \right\}$$

RE_p : Reference emissions during the period *p* [tCO_2/p]

$EC_{PJ,i,p}$: Power consumption of project chiller *i* during the period *p* [MWh/p]

$COP_{PJ,tc,i}$: 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]

G. Calculation of project emissions

$$\mathbf{PE_p = \sum_i \left(EC_{PJ,i,p} \times EF_{elec}\right)}$$

PE_p : Project emissions during the period *p* [tCO_2/p]
$EC_{PJ,i,p}$: Power consumption of project chiller *i* during the period *p* [MWh/p]
EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

H. Calculation of emissions reductions

$$\mathbf{ER_p = RE_p - PE_p}$$

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 *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
EF_{elec}	CO_2 emission factor for consumed electricity. When project chiller consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project chiller may consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factors for grid and captive electricity proportionately. Proportion of captive electricity is derived from	[Grid electricity] The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Emission Factors of Electricity

<table>
<tr><th>Parameter</th><th>Description of data</th><th>Source</th></tr>
<tr><td></td><td>dividing captive electricity generated by total electricity consumed at the project site. The total electricity consumed is a summation of grid electricity imported ($EI_{grid,p}$) and captive electricity generated ($EG_{gen,p}$)* during the monitoring period.

* Captive electricity generated can be derived from metering electricity generated or monitored operating time ($h_{gen,p}$) and rated capacity of generator (RC_{gen}).

[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: 0.8* [tCO_2/MWh]
*The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.</td><td>Interconnection Systems”, National Committee on Clean Development Mechanism Indonesian DNA for CDM unless otherwise instructed by the Joint Committee.
[Captive electricity]
CDM approved small scale methodology: AMS-I.A</td></tr>
<tr><td>$COP_{RE,i}$</td><td>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.

$COP_{RE,i}$<table><tr><th>Cooling capacity /unit (USRt)</th><th>x<300</th><th>300≦ x<450</th><th>450≦ x<500</th><th>500≦ x<700</th><th>700≦ x<1,250</th></tr><tr><td>$COP_{RE,i}$</td><td>4.92</td><td>5.33</td><td>5.59</td><td>5.85</td><td>5.94</td></tr></table></td><td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by manufacturer.

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 $COP_{RE,i}$ should be</td></tr>
</table>

Parameter	Description of data	Source
		revised if necessary from survey result which is conducted by JC or project participants every three years.
$COP_{PJ,i}$	The COP of project chiller *i* under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
$T_{cooling-out,i}$	Output cooling water temperature of project chiller *i* set under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
$T_{chilled-out,i}$	Output chilled water temperature of project chiller *i* set under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
RC_{gen}	Rated capacity of generator, where applicable.	Specification of generator for captive electricity

History of the document

Version	Date	Contents revised
01.0	17 September 2014	Electronic decision by the Joint Committee Initial approval.