JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	

Form for submitting the proposed methodology

Host Country	Kingdom of Thailand
Name of the methodology proponents submitting this form	Sony Corporate Services (Japan) Corporation
Sectoral scope(s) to which the Proposed Methodology applies	3. Energy demand
Title of the proposed methodology, and version number	Energy Saving by Introduction of High Efficiency Centrifugal Chiller, Version 1.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information
Date of completion	05/08/2016

History of the proposed methodology

Version	Date	Contents revised
1.0	05/08/2016	First edition

A. Title of the methodology

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

B. Terms and definitions

Terms	Definitions
Inverter type centrifugal chiller	An inverter type centrifugal chiller is a chiller which contains inverter, an apparatus to control the speed of the compressor motor in order to maintain the ambient temperature, and includes a centrifugal compressor.
Non-inverter type centrifugal chiller	A non-inverter type centrifugal chiller is a chiller which includes a centrifugal compressor but does not contain inverter.
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 Thailand.
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 ● The amount of fuel consumed and the amount of electricity generated by captive power, 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 which is less than or equals to 1,500 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 the threshold COP values set in the tables below. ("x" in the table represents cooling capacity per unit.) For the project chiller of non-inverter type: (see table A below) For the project chiller of inverter type: (see table B below) $COP_{PJ,tc,i}$ is calculated by altering the temperature conditions of COP of project chiller *i* ($COP_{PJ,i}$) from the project specific conditions to the standardizing conditions. $COP_{PJ,i}$ is derived from specifications prepared for the quotation or factory acceptance test data by manufacturer. [equation to calculate $COP_{PJ,tc,i}$] $$\mathbf{COP_{PJ,tc,i} = COP_{PJ,i} \times [(T_{cooling-out,i} - T_{chilled-out,i} + TD_{chilled} + TD_{cooling}) \div (37 - 7 + TD_{chilled} + TD_{cooling})]}$$ $COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions* [-]

Table A (non-inverter type):

	Cooling capacity per unit (USRt)	
	250≤x<400	**400≤x≤1,220**
Threshold COP value	5.67	6.19

Table B (inverter type):

	Cooling capacity per unit (USRt)			
	300≤x≤450	**450<x≤550**	**550<x≤825**	**825<x≤1,500**
Threshold COP value	5.59	5.69	5.85	6.06

	$COP_{PJ,i}$: 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 conditions [degree Celsius] $T_{chilled-out,i}$: Output chilled water temperature of project chiller *i* set under the project specific conditions [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 degrees Celsius input 12 degrees Celsius Cooling water: output 37 degrees Celsius input 32 degrees Celsius
Criterion 3	Periodical check is planned more than one (1) time annually.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.
Criterion 5	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 equipment. 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.

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 reference COP value varies by its cooling capacity.
2. The maximum values of COP in each cooling capacity range set for this methodology are defined as $COP_{RE,i}$ as described in Section I.

F.2. Calculation of reference emissions

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

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

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

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 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 (η_{elec} [%]) obtained from manufacturer's specification The power generation efficiency based on lower	[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 "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization 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 (η_{elec} [%]).

	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 certificate is issued by an entity accredited under national/international standards; $$EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$$ Where: NCV_{fuel} : Net calorific value of consumed fuel [GJ/mass or weight]	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} [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.
$COP_{RE,i}$	The COP of the reference chiller *i* is selected from the default COP value in the following tables in line with non-inverter/inverter type and cooling capacity of the project chiller *i*. ("x" in the table represents	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by

<table>
<tr>
<td></td>
<td>cooling capacity per unit.)

Non-inverter type
<table>
<tr><td></td><td colspan="2">Cooling capacity per unit (USRt)</td></tr>
<tr><td></td><td>250≤x<400</td><td>400≤x≤1,220</td></tr>
<tr><td>$COP_{RE,i}$</td><td>5.67</td><td>6.19</td></tr>
</table>

Inverter type
<table>
<tr><td></td><td colspan="4">Cooling capacity per unit (USRt)</td></tr>
<tr><td></td><td>300≤x≤450</td><td>450<x≤550</td><td>550<x≤825</td><td>825<x≤1,500</td></tr>
<tr><td>$COP_{RE,i}$</td><td>5.59</td><td>5.69</td><td>5.85</td><td>6.06</td></tr>
</table>
</td>
<td>manufacturer.

The default COP values are derived from the result of survey on COP of chillers from manufacturers that have high market share. The survey should prove the use of clear methodology. The $COP_{RE,i}$ should be revised if necessary from survey result which is conducted by JC or project participants every three years.</td>
</tr>
<tr>
<td>$COP_{PJ,i}$</td>
<td>The COP of project chiller i under the project specific conditions.</td>
<td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by manufacturer</td>
</tr>
<tr>
<td>$T_{cooling-out,i}$</td>
<td>Output cooling water temperature of project chiller i set under the project specific conditions.</td>
<td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by manufacturer</td>
</tr>
<tr>
<td>$T_{chilled-out,i}$</td>
<td>Output chilled water temperature of project chiller i set under the project specific conditions.</td>
<td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by manufacturer</td>
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