Joint Crediting Mechanism Approved Methodology ID_AM022

"Introduction of Absorption Chiller"

A. Title of the methodology

Introduction of Absorption Chiller, Version 01.0

B. Terms and definitions

Terms	Definitions
Absorption chiller	Refrigerating machine using heat source such as heating energy generated by fuel combustion and/or waste heat in the form of hot water, steam or exhaust gas, refrigerant (e.g. water) and absorption solution (e.g. Lithium bromide, ammonia) to generate chilled water or other chilled liquids by absorption refrigeration cycle.
Cooling capacity	Capability of individual chiller to remove heat. In this methodology, "cooling capacity" is used to represent a cooling capacity per a single chiller unit and not for a system with multiple chiller units.
Periodical check	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	Absorption chiller is introduced to replace reference centrifugal chiller(s), which leads to save energy and GHG emission reductions.
Calculation of reference emissions	Reference emissions are GHG emissions from using reference chiller(s) which is determined as centrifugal chiller in this methodology. Reference emissions are calculated with cooling energy of project chiller(s), COP (Coefficient Of Performance) of

	reference chiller, and CO_2 emission factor for consumed electricity. GHG emissions from using chilled water pump, cooling water pump and cooling tower are excluded from calculation since those pumps exist in both reference and project chiller system, and they can cancel each other out.
Calculation of project emissions	Project emissions are GHG emissions from using project chiller(s), which are the sum of emissions from electricity consumption and fossil fuel consumption. GHG emissions from electricity consumption are calculated with power consumption of pumps for absorbing solution and refrigerant built in the project chiller(s) and hot water pumps where applicable and CO_2 emission factor for consumed electricity. GHG emissions from fossil fuel consumption are calculated with fuel consumption of project chiller(s) and CO_2 emission factor for fuel consumed. GHG emissions from using chilled water pump, cooling water pump and cooling tower are excluded from calculation since those pumps exist in both reference and project chiller system, and they can cancel each other out.
Monitoring parameters	● Cooling energy generated by project absorption chiller ● Power consumption by project absorption chiller ● Gas fuel consumption by project absorption chiller

D. Eligibility criteria

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

Criterion 1	Project chiller is an absorption chiller with a cooling capacity which is less than or equals to 1,300 USRt. * 1 USRt = 3.52 kW
Criterion 2	Periodical check is planned more than four (4) times annually.
Criterion 3	In the case of replacing the existing chiller with the project chiller, a plan for prevention of releasing refrigerant used in the existing chiller to the air (e.g. re-use of the equipment) is prepared. Execution of this plan is checked at the time of verification, in order to confirm that refrigerant used for the existing one replaced by the project is prevented from being released to the air. In the case that the existing chiller is NOT replaced with the project chiller, this criterion is not applied.

Criterion 4	In the case that project absorption chiller uses fossil fuel for its heat source, such fossil fuel is gas fuel.

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 absorption chiller	CO_2
Gas fuel consumption by project absorption chiller	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated with cooling energy of project chiller(s), COP of reference chiller, and CO_2 emission factor for consumed electricity.
GHG emissions from using chilled water pump, cooling water pump and cooling tower are excluded from calculation since those pumps exist in both reference and project chiller system, and they can cancel each other out.
The COP of reference chiller, which is a centrifugal 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 value varies by the cooling capacity of chillers.
3. 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

$$RE_p = \sum_i \left(\frac{C_{PJ,i,p}}{COP_{RE,i}} \times EF_{elec} \right)$$

Where

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

$C_{PJ,i,p}$	Cooling energy generated by project absorption chiller *i* during the period *p* [MWh/p]
$COP_{RE,i}$	COP of reference chiller *i* [-]
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh]
i	Identification number of the project absorption chiller

G. Calculation of project emissions

$$\boldsymbol{PE_p = \sum_i \left(EC_{PJ,i,p} \times EF_{elec}\right) + \sum_i \left(FC_{PJ,i,p} \times NCV_{fuel,i} \times 1{,}000^{-1} \times EF_{fuel,i}\right)}$$

Where

PE_p	Project emissions during the period *p* [tCO_2/p]
$EC_{PJ,i,p}$	Electricity consumption by project absorption chiller *i* during the period *p* [MWh/p]
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh]
$FC_{PJ,i,p}$	Gas fuel consumption by project absorption chiller *i* during the period *p* [Nm^3/p]
$NCV_{fuel,i}$	Net calorific value of gas fuel consumed by project absorption chiller *i* [MJ/Nm^3]
$EF_{fuel,i}$	CO_2 emission factor for gas fuel consumed by project absorption chiller *i* [tCO_2/GJ]
i	Identification number of the project absorption chiller

H. Calculation of emissions reductions

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

Where

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.

<table>
<tr><th>Parameter</th><th>Description of data</th><th>Source</th></tr>
<tr><td>EF_{elec}</td><td>CO_2 emission factor for consumed electricity [tCO_2/MWh].

When the facility consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively.
When the facility consumes 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: 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>[Grid electricity]
The data is sourced from “Emission Factors of Electricity Interconnection Systems”, National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of Energy and Mineral Resources, Indonesia, 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>COP of reference chiller i

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. (“x” in the table represents cooling capacity per unit.)

[Default COP values of reference chillers]
<table>
<tr><td>Cooling capacity per unit (USRt)</td><td>x≤350</td><td>350<x≤ 550</td><td>550<x ≤750</td><td>750<x ≤1,300</td></tr>
<tr><td>$COP_{RE,i}$</td><td>5.46</td><td>5.69</td><td>5.90</td><td>6.03</td></tr>
</table></td><td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by 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 default COP values should be revised if necessary from survey result</td></tr>
</table>

		which is conducted by JC or project participants.
$NCV_{fuel,i}$	Net calorific value of gas fuel consumed by project absorption chiller *i* [MJ/Nm^3]	In the order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.
$EF_{fuel,i}$	CO_2 emission factor for gas fuel consumed by project absorption chiller *i* [tCO_2/GJ]	In order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Higher value is applied.

History of the document

Version	Date	Contents revised
01.0	31 October 2019	JC9, Annex 3 Initial approval.