Joint Crediting Mechanism Approved Methodology VN_AM006

"Introduction of air conditioning system equipped with inverters"

A. Title of the methodology

Introduction of air conditioning system equipped with inverters, Version 01.1

B. Terms and definitions

Terms	Definitions
Air-conditioning system with inverters	Air-conditioning system with inverters is a type of air conditioning system which contains inverter, an apparatus to control the speed of the compressor motor in line with different load demand.
Coefficient of Performance (COP)	Coefficient of Performance (COP) is the cooling capacity per rated electricity consumption of the air conditioning system. The values of cooling capacity and rated electricity consumption are defined under specific temperature stated in ISO5151:2010. In this methodology, a COP value of project air conditioning system is set based on calculation by the value of its cooling capacity divided by the electricity consumption of the outdoor unit according to data by manufacturer.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	This methodology applies to the project that aims for saving energy by introducing air-conditioning system with inverter for cooling in Vietnam.

Calculation of reference emissions	GHG emissions associated with electricity consumption of reference air conditioning system are calculated based on the monitored electricity consumption of project air conditioning system, the ratio of COPs of reference/project air conditioning system, and the CO_2 emission factor of the electricity consumed by project air conditioning system.
Calculation of project emissions	GHG emissions associated with electricity consumption of project air conditioning system are calculated based on the monitored electricity consumption of project air conditioning system and the CO_2 emission factor of the electricity consumed by project air conditioning system.
Monitoring parameters	● Electricity consumption of outdoor unit of project air conditioning system ● Total electricity consumption of indoor units of project air conditioning system

D. Eligibility criteria

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

Criterion 1	Air-conditioning system with inverter is newly installed or installed to replace existing non-inverter air conditioning system.
Criterion 2	Cooling capacity of project air conditioning system is more than or equal to 14kW.
Criterion 3	COP of project air-conditioning system has a COP value higher than that of the value indicated in the table below. **COP for Reference Air Conditioning System ($COP_{RE,i}$)** Cooling Capacity [kW] / Reference COP $14 \leq x < 28$ / 2.97 $28 \leq x < 42$ / 2.94 $42 \leq x < 56$ / 2.91 $56 \leq x$ / 2.56
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project air conditioning system is zero.

Criterion 5	Plans to prevent release of refrigerants into the atmosphere at the time of air conditioning system removal are prepared for both project air conditioning system and the existing air conditioning system replaced by the project. In the case of replacing existing air conditioning system by project air conditioning system, execution of the prevention plan is checked at the time of verification, e.g. re-use of the refrigerant, in order to confirm that refrigerant used for the existing air conditioning system removed by the project is not released to the air.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption by reference air conditioning systems	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption by project air conditioning systems (include an indoor unit and an outdoor unit)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated with electricity consumption of project air conditioning system, ratio of COPs of project/reference air conditioning system, and CO_2 emission factor for electricity consumed.
Taking into consideration the market of air conditioning system in Viet Nam, the COP of reference air conditioning system is conservatively set *ex ante* in the following manner to ensure the net emission reductions.

- The reference COP, at a certain cooling capacity, is set at the maximum value among the COP values of the air conditioning systems of single-split type and non-inverter type, which are currently available in the Vietnamese market, in the respective cooling capacity range.

F.2. Calculation of reference emissions

$$\boldsymbol{RE_p = \sum_i \{EC_{PJ,i,outdoor,p} \times (COP_{PJ,i,outdoor} \div COP_{RE,i})\} \times EF_{elec}}$$

RE_p	: Reference emissions during the period p [tCO_2/p]
$EC_{PJ,i,outdoor,p}$	: Electricity consumption of outdoor unit of project air conditioning system i during the period p [MWh/p]
$COP_{PJ,i,outdoor}$	: COP of outdoor unit of project air conditioning system i [-]
$COP_{RE,i}$	: COP of reference air conditioning system i [-]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
i	: Identification number of air conditioning system [-]

G. Calculation of project emissions

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

PE_p	: Project emissions during the period p [tCO_2/p]
$EC_{PJ,i,outdoor,p}$	: Electricity consumption of outdoor unit of project air conditioning system i during the period p [MWh/p]
$EC_{PJ,indoor,p}$	: Total electricity consumption of indoor units of project air conditioning system during the period p [MWh/p]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
i	: Identification number of air conditioning system [-]

H. Calculation of emissions reductions

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

ER_p	: Emissions 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 air-conditioning system consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project air-conditioning system 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) Calculated from its power generation efficiency ($\eta_{elec,CG}$ [%]) 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; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec,CG}} \times EF_{fuel,CG}$$ b) Calculated from measured data The power generation efficiency calculated from	[Grid electricity] Ministry of Natural Resources and Environment of Vietnam (MONRE), Vietnamese DNA for CDM unless otherwise instructed by the Joint Committee. [Captive electricity] For the option a) Specification of the captive power generation system provided by the manufacturer ($\eta_{elec,CG}$ [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system ($EF_{fuel,CG}$ [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,CG,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,CG,p}$ [mass or volume/p]). Net calorific value ($NCV_{fuel,CG}$ [GJ/mass or volume]) and CO_2 emission factor ($EF_{fuel,CG}$ [tCO_2/GJ])

<table>
<tr>
<td></td>
<td>monitored data of the amount of fuel input for power generation ($FC_{PJ,CG,p}$) and the amount of electricity generated ($EG_{PJ,CG,p}$) 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;
$EF_{elec} = FC_{PJ,CG,p} \times NCV_{fuel,CG} \times EF_{fuel,CG} \times \frac{1}{EG_{PJ,CG,p}}$
Where:
$NCV_{fuel,CG}$: Net calorific value of fuel consumed by the captive power generation system [GJ/mass or volume]

Note:
In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to EF_{elec} depending on the consumed fuel type.

● The system is non-renewable generation system
● Electricity generation capacity of the system is less than or equal to 15 MW

<table><tr><th>fuel type</th><th>Diesel fuel</th><th>Natural gas</th></tr><tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr></table>
*1 The most recent value at the time of validation is applied.
*2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas</td>
<td>of the fuel consumed by the captive power generation system 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 tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.

[Captive electricity with diesel fuel]
CDM approved small scale methodology: AMS-I.A.

[Captive electricity with natural gas]
2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.
CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants.</td>
</tr>
</table>

<table>
<tr><td></td><td>(0.0543 tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.</td><td></td></tr>
<tr><td>$COP_{RE,i}$</td><td>COP of reference air conditioning system i, as indicated in Table 1. The values of cooling capacity and rated electricity consumption used in the calculation of COP are obtained from product catalogs, specification documents or website, hearing survey of major manufacturers in Vietnam.

Table 1 : COP for Reference Air Conditioning System ($COP_{RE,i}$)<table><tr><th>Cooling Capacity [kW]</th><th>Reference COP</th></tr><tr><td>14 ≤ x < 28</td><td>2.97</td></tr><tr><td>28 ≤ x < 42</td><td>2.94</td></tr><tr><td>42 ≤ x < 56</td><td>2.91</td></tr><tr><td>56 ≤ x</td><td>2.56</td></tr></table></td><td>Nominal value available on product catalogs, specification documents or websites, hearing survey.

The default values are derived from the result of survey on COP of air conditioning system with non-inverter from manufacturers that have high market share.
The default values should be revised if necessary from survey result which is conducted by JC or project participants every three years. The survey should prove the use of clear methodology.</td></tr>
<tr><td>$COP_{PJ,i,outdoor}$</td><td>COP of outdoor unit of project air conditioning system i. The COP is calculated by using the value of cooling capacity and rated electricity consumption of outdoor unit provided by manufacturer.</td><td>Specifications of project air conditioning system for the quotation or factory acceptance test data by manufacturer.</td></tr>
</table>

History of the document

Version	Date	Contents revised
01.1	10 October 2017	JC6 ● Revision of methods to determine CO_2 emission factor for consumed electricity in section I
01.0	20 October 2016	JC5, Annex 7 Initial approval.