Joint Crediting Mechanism Approved Methodology VN_AM015

"Installation of compressor control system(s) for split type air conditioner(s)"

A. Title of the methodology

Installation of compressor control system(s) for split type air conditioner(s), Version 01.0

B. Terms and definitions

Terms	Definitions
Compressor control system(s)	A system that improves operation efficiency of split type air conditioners by preventing excessive cooling through the utilization of pre-programmed switching on/off schedules of compressors. The pre-programmed switching on/off schedules of compressors constantly monitors operation status of the compressor equipped in the air conditioner outdoor unit by measuring an electric current at the optimum programmed timing.
Split type air conditioner(s)	A type of air conditioner(s) allows one outdoor unit to be connected with a wide variety of indoor units, including wall mounted, consoles, cassette, and ducted units.
Energy saving factor	Energy saving rate realized through pre-programmed switching on/off schedules by installing compressor control system for split type air conditioner(s)

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Energy saving achieved by compressor control system(s) for split type air conditioner(s).
Calculation of reference emissions	Reference emissions are calculated based on the monitored electricity consumption of compressor of outdoor unit in project split type air conditioner(s) with compressor control system(s), the project energy saving factor, and the CO_2 emission factor of

	the electricity consumed by project split type air conditioner(s).
Calculation of project emissions	Project emissions are calculated based on the monitored electricity consumption of compressor of outdoor unit in project split type air conditioner(s) with compressor control system(s) and the CO_2 emission factor of the electricity consumed by project split type air conditioner(s).
Monitoring parameters	Electricity consumption of compressor of outdoor unit in project split type air conditioner(s) with installation of compressor control system(s)

D. Eligibility criteria

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

Criterion 1	The project installs compressor control system(s) for new and/or existing non-inverter split type air conditioners utilizing electric heat pump.
Criterion 2	The compressor control system(s) has a function to measure electric current of compressor(s) at the sampling rate of 0.01 seconds or below and to estimate the amount of electricity consumption of compressor(s) in non-inverter split type air conditioner system(s).

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption by compressor of outdoor unit in new and/or existing non-inverter split type air conditioner(s) without compressor control system	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption of compressor of outdoor unit in project split type air conditioner(s) with compressor control system(s)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are established based on the monitored electricity consumption of compressor of outdoor unit in project split type air conditioners, the project energy saving factor, and the CO_2 emission factor of the electricity consumed by project split type air conditioners.

The project energy saving factor by installation of the compressor control system(s) is determined by the following procedures to ensure net emission reductions.

Step 1: Once after the installation of the compressor control system(s) in the project activity, switch the compressor control system(s) *on(activate)* and *off(inactivate)* consecutively at the 30-minute interval at pre-programmed switching on/off schedules before starting monitoring period. Secondly take continuous measurements on electricity consumption of compressors in the air conditioners for both *on* and *off* cases at an interval of at least 0.01 second by internal functions of compressor control system(s) for at least one operating day.

Step 2: Collect measured electricity consumption data by all installed compressor control system(s) during period examined. All the data is aggregated to total electricity consumption for both *on* and *off* cases, respectively per installed compressor control system(s).

Note:
In case the number of the installed compressor control system(s) exceeds 10 units, random sampling may be conducted. The sample size can be determined in line with the latest version of "Guideline Sampling and surveys for CDM project activities and programmes of activities" and "Standard Sampling and surveys for CDM project activities and programmes of activities" applicable at the time of conducting the sampling. Simple random sampling can be utilized if areas where the compressor control systems are installed belong to the same region described in explanatory note 1, and if the same pre-programmed on/off switching schedules are applied to all compressor control systems installed.

Step 3: Compare electricity consumption data of all collected or sampled compressor control systems(s) for *on* and *off* cases and calculate the percentage of electricity consumption saved expressed as calculated energy saving factor of each data or sample. Calculate the energy saving factor as follows.

$$\eta_{j,pe} = \left(EC_{PJ,sys,off,j,pe} - EC_{PJ,sys,on,j,pe}\right) \div EC_{PJ,sys,off,j,pe}$$

j	:	An index variable that is used to count the number of all or sampled compressor control system(s) which is installed to split type air conditioner(s) for determination of calculated energy saving factor.
$\eta_{j,pe}$	:	Calculated energy saving factor determined by the compressor control system j which is installed to the split type air conditioner during the period examined pe [-]
$EC_{PJ,sys,on,j,pe}$	:	Electricity consumption of compressor measured by the compressor control system j which is installed to the project split type air conditioner with activating compressor energy saving control during the period examined pe [MWh/pe]
$EC_{PJ,sys,off,j,pe}$	:	Electricity consumption of compressor measured by the compressor control system j which is installed to the project split type air conditioner with inactivating compressor energy saving control system during the period examined pe [MWh/pe]

Step 4: Determine the project energy saving factor with (1) averaged energy saving factor (defined as η_{ave}) which is derived by averaging the calculated energy saving factor(s) and (2) standard deviation (defined as σ) by every energy saving factor of split type air conditioner j. Project energy saving factor η is set as follows by subtracting standard deviation (σ) from averaged energy saving factor (η_{ave}) to ensure net emission reductions.

$$\eta = \eta_{ave} - \sigma$$

Where,

$$\eta_{ave} = \frac{1}{j}\sum_{j}\eta_{j,pe}$$

In case of using all data,

$$\sigma = \sqrt{\frac{1}{j}\sum_{j}(\eta_{j,pe} - \eta_{ave})^2}$$

In case of using sampled data,

$$\sigma = \sqrt{\frac{1}{j-1}\sum_{j}(\eta_{j,pe} - \eta_{ave})^2}$$

η_{ave}	:	Averaged energy saving factor of compressor in split type air conditioner(s) [-]
σ	:	Standard deviation of energy saving factor of compressor in split type air

		conditioner(s) [-]
η	:	Project energy saving factor [-]

F.2. Calculation of reference emissions

$$RE_p = \sum_{i=1} EC_{PJ,i,p} \div (1-\eta) \times EF_{elec}$$

Where

RE_p	:	Reference emissions during the period p [tCO_2/p]
$EC_{PJ,i,p}$	:	Electricity consumption of compressor of outdoor unit in project split type air conditioner(s) i which is installed compressor control system(s) during the period p [MWh/p]
i	:	An index variable that is used to count the number of all project split type air conditioner(s) which is installed compressor control system(s)
η	:	Project energy saving factor [-]
EF_{elec}	:	CO_2 emission factor of consumed electricity [tCO_2/MWh]

G. Calculation of project emissions

$$\boldsymbol{PE_p = \sum_{i=1} EC_{PJ,i,p} \times EF_{elec}}$$

Where

PE_p	:	Project emissions during the period p [tCO_2/p]
$EC_{PJ,i,p}$	:	Electricity consumption of compressor of outdoor unit in project split type air conditioner(s) i which is installed compressor control system(s) during the period p [MWh/p]
EF_{elec}	:	CO_2 emission factor of consumed electricity [tCO_2/MWh]

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

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.

Parameter	Description of data	Source
EF_{elec}	CO_2 emission factor of consumed electricity. When project compressor of outdoor unit consume only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project compressor of outdoor unit 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;	[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]).

	$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec,CG}} \times EF_{fuel,CG}$ b) Calculated from measured data The power generation efficiency calculated from 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 fuel type / Diesel fuel / Natural gas EF_{elec} / 0.8 *1 / 0.46 *2	Net calorific value ($NCV_{fuel,CG}$ [GJ/mass or volume]) and CO_2 emission factor ($EF_{fuel,CG}$ [tCO_2/GJ]) 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

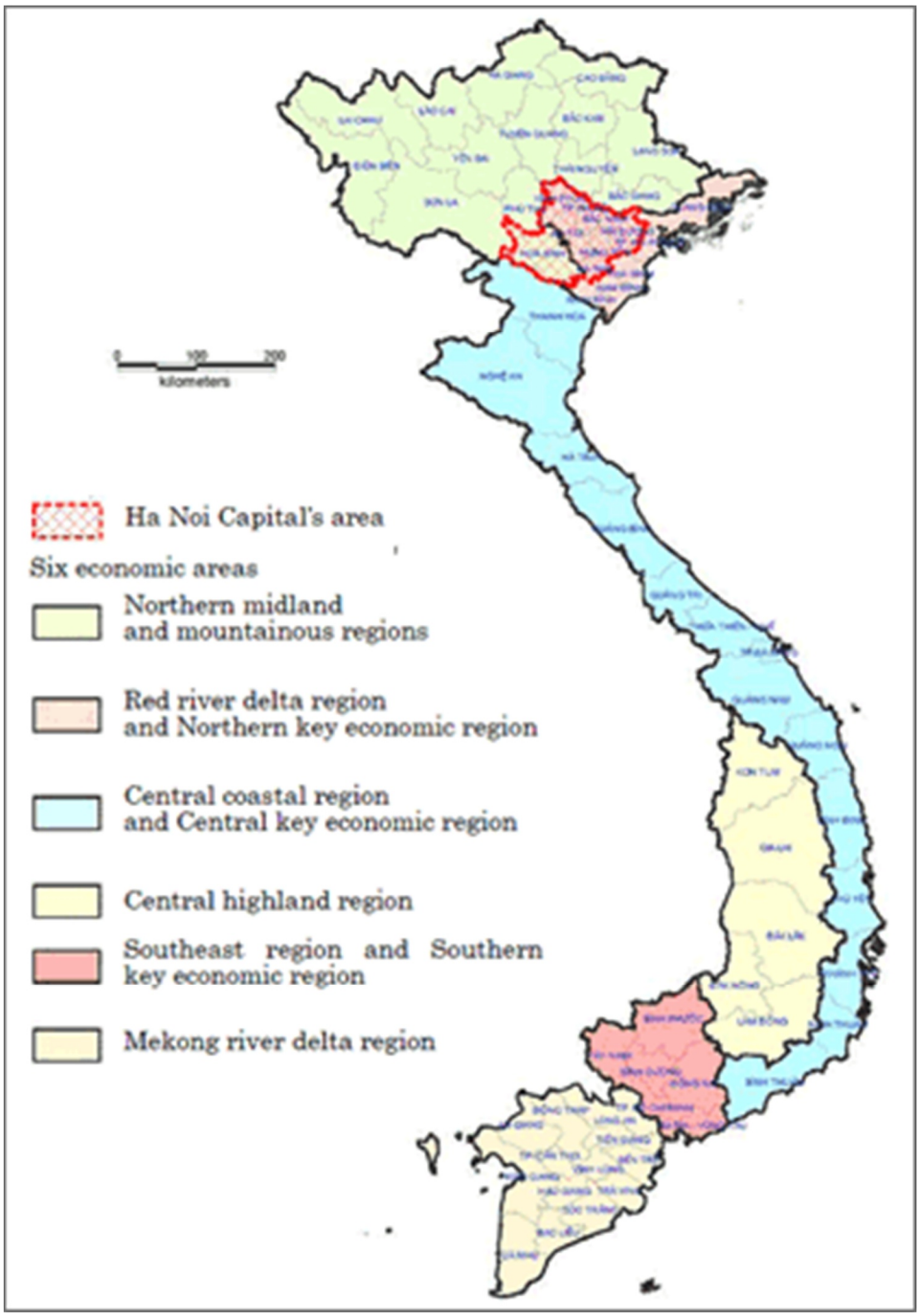
	*1 The most recent value at the time of validation is applied. *2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas (0.0543 tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.	default efficiency for off-grid power plants
η	Project energy saving factor [-]	Determined as per the procedure described in Section F.1

History of the document

Version	Date	Contents revised
01.0	28 May 2019	JC8, Annex 1 Initial approval.

(Explanatory note 1)

The region of Viet Nam is divided into 6 administrative units, *Red river delta*, *Northern midland mountain area*, *North central and central coastal area*, *Central highlands*, *South east*, and *Mekong river delta*, according to General statistics office of Viet Nam.
http://www.gso.gov.vn/default_en.aspx?tabid=515&idmid=5&ItemID=18533



Source: Map of Viet Nam, Ministry of Land, Infrastructure, Transport and Tourism, JAPAN
http://www.mlit.go.jp/kokudokeikaku/international/spw/general/vietnam/index_e.html