Joint Crediting Mechanism Approved Methodology ID_AM017

"Installation of Solar PV System and Storage Battery System"

A. Title of the methodology

Installation of Solar PV System and Storage Battery System, Ver. 01.0

B. Terms and definitions

Terms	Definitions
Solar photovoltaic (PV) system	An electricity generation system which converts sunlight into electricity by the use of photovoltaic (PV) modules. The system also includes ancillary equipment such as inverters required to change the electrical current from direct current (DC) to alternating current (AC).
Storage battery system	The storage battery system which is consisted of power converter(s) and connected group of battery cell charges and discharges itself by converting electrical energy into chemical energy.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Displacement of grid electricity and/or captive electricity by installation and operation of solar PV system(s) and storage battery system(s).
Calculation of reference emissions	Reference emissions are calculated on the basis of the amount of the electricity displaced by the project multiplied by either: 1) conservative emission factor of the grid, or 2) conservative emission factor of the captive diesel power generator.
Calculation of project emissions	Project emissions are the emissions from the solar PV system(s) and the storage battery system(s), which are assumed to be zero.
Monitoring parameters	The quantity of the electricity generated by the project solar PV system(s) and charge and discharge amounts of the storage battery system(s) as necessary depending on the selected option

	for calculation of reference emissions.

D. Eligibility criteria

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

Criterion 1	The solar PV system(s) and storage battery system(s) are newly installed.
Criterion 2	The PV modules are certified for design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2).
Criterion 3	The equipment to monitor output power of the solar PV system(s) and irradiance is installed at the project site.
Criterion 4	In the case of replacing the existing storage battery system (s), a plan is prepared in which mercury used in the existing storage battery system (s) is not released to the environment. Execution of the prevention plan is checked at the time of verification, in order to confirm that mercury used for the existing one replaced by the project is not released to the environment.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Consumption of grid electricity and/or captive electricity	CO_2
Project emissions	
Emission sources	GHG types
Generation of electricity from the solar PV system(s)	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

The default emission factor is set in a conservative manner for the Indonesian regional grids. The emission factor is calculated based on the conservative operating margin that reflects on the latest electricity mix including low cost/must run (LCMR) resources for each regional grid in Indonesia during the year 2013-2015 and refers to the conservative emission factor of each fossil fuel power plant in order to secure net emission reductions. The conservative emission factor of each plant are calculated as 0.795 t-CO_2/MWh for coal-fired power plant and 0.320 t-CO_2/MWh for gas-fired power plant based on the survey on heat efficiency of power plant in

Indonesia. The emission factor for diesel power plant is calculated as 0.533 t-CO_2/MWh based on a default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel power generators.

In case the PV system(s) in a proposed project activity is directly connected or connected via an internal grid, not connecting either an isolated grid or a captive power generator, to a national/regional grid (PV Case 1), the value of operating margin including LCMR resources, using the best heat efficiency among currently operational plants in Indonesia for the calculated emission factors of fossil fuel power plants, is applied. The emission factors to be applied are shown in column "Emission factor for PV Case 1 (tCO_2/MWh)" of Table 1 of the additional information.

In the case the PV system(s) in a proposed project activity is connected to an internal grid connecting to both a national/regional, and an isolated grid and/or a captive power generator (PV Case 2), the lower values between emission factors as shown in Section I. and the conservative emission factors of diesel-fired power plant of 0.533 t-CO_2/MWh is applied. The emission factors to be applied for PV Case 2 (t-CO_2/MWh) are shown in Section I.

In the case that the PV system(s) in a proposed project activity is only connected to an internal grid connecting to an isolated grid and/or a captive power generator (PV Case 3), the emission factor of a diesel generator calculated by applying the efficient heat efficiency of 49%, an efficiency level which has not been achieved yet by the world's leading diesel generator is applied, which is set as 0.533 tCO_2/MWh.

The result of calculation for emission factors to be applied for each case is shown in Section I.

F.2. Calculation of reference emissions

For calculation of reference emissions, either Option1, Option2, Option3-1 or Option3-2 is selected.

Option1:

$$RE_p = \sum_{i,j} \left\{ EG_{i,p} \times (1 - LR_{j,p}) \right\} \times EF_{RE}$$

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

$EG_{i,p}$: Quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

$LR_{j,p}$: Loss ratio of charge and discharge on the project storage battery system *j* during the period *p* [%]

EF_{RE} : Reference CO_2 emission factor for the project system [tCO_2/MWh]

i : Identification number of project solar PV system

j : Identification number of the project storage battery system

Option2:

$$RE_p = \sum_{i,j} \{EG_{i,p} - EC_{i,j,p} \times LR_{j,p}\} \times EF_{RE}$$

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

$EG_{i,p}$: Quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

$EC_{i,j,p}$: Quantity of the electricity charged by the project solar PV system *i* to the project storage battery system *j* during the period *p* [MWh/p]

$LR_{j,p}$: Loss ratio of charge and discharge on the project storage battery system *j* during the period *p* [%]

EF_{RE} : Reference CO_2 emission factor for the project system [tCO_2/MWh]

Option3-1 (In case the project storage battery system(s) are only charged by the project PV system(s)):

$$RE_p = \sum_{i,j} \{EG_{i,p} - EC_{i,j,p} + ED_{j,p}\} \times EF_{RE}$$

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

$EG_{i,p}$: Quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

$EC_{i,j,p}$: Quantity of the electricity charged by the project solar PV system *i* to the project storage battery system *j* during the period *p* [MWh/p]

$ED_{j,p}$: Quantity of the electricity discharged from the project storage battery system *j* during the period *p* [MWh/p]

EF_{RE} : Reference CO_2 emission factor for the project system [tCO_2/MWh]

Option3-2 (In case the project storage battery system(s) are charged by electricity sources other

than the project PV system(s)):

$$RE_p = \sum_{i,j} \{EG_{i,p} - EC_{i,j,p} + ED_{j,p} \times EC_{i,j,p} \div ECA_{j,p}\} \times EF_{RE}$$

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

$EG_{i,p}$: Quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

$EC_{i,j,p}$: Quantity of the electricity charged by the project solar PV system *i* to the project storage battery system *j* during the period *p* [MWh/p]

EF_{RE} : Reference CO_2 emission factor for the project system [tCO_2/MWh]

$ED_{j,p}$: Quantity of the electricity discharged from the project storage battery system *j* during the period *p* [MWh/p]

$ECA_{j,p}$: Quantity of the electricity charged by all electricity sources to the project storage battery system *j* during the period *p*[MWh/p]

G. Calculation of project emissions

$PE_p = 0$

PE_p : Project emissions during the period *p* [tCO_2/p]

H. Calculation of emissions reductions

$ER_p = RE_p - PE_p$

$= RE_p$

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_{RE}	Reference CO_2 emission factor for the project system. The value for EF_{RE} is selected from the emission	The default emission factor value is obtained from a study of electricity

	factors based on the national/regional grid ($EF_{RE,grid}$) or based on isolated grid and/or a captive diesel power generator ($EF_{RE,cap}$) in the following manner: In case the PV system(s) and storage battery system(s) in a proposed project activity are directly connected, or connected via an internal grid not connecting to either an isolated grid or a captive power generator, to a national/regional grid (PV Case1), EF_{RE} is set as follows: Jamali grid 0.616 tCO_2/MWh Sumatra grid 0.477 tCO_2/MWh Batam grid 0.664 tCO_2/MWh Tanjung Pinang, Tanjung Balai Karimun, Tanjung Batu, Kelong, Ladan, Letung, Midai, P Buru, Ranai, Sedanau, Serasan, and Tarempa grids 0.555 tCO_2/MWh Bangka, Belitung, S Nasik, and Seliu grids 0.553 tCO_2/MWh Khatulistiwa grid 0.532 tCO_2/MWh Barito grid 0.666 tCO_2/MWh Mahakam grid 0.527 tCO_2/MWh Tarakan grid 0.493 tCO_2/MWh Sulutgo grid 0.325 tCO_2/MWh Sulselbar grid 0.320 tCO_2/MWh Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids 0.593 tCO_2/MWh Palu Parigi grid 0.517 tCO_2/MWh Lombok, Bima, and Sumbawa grids 0.561 tCO_2/MWh Kupang, Ende, Maumere, and Waingapu grids 0.507 tCO_2/MWh Ambon, Tual, and Namlea grids 0.533 tCO_2/MWh Tobelo and Ternate Tidore grids 0.532 tCO_2/MWh Jayapura, Timika, and Genyem grids 0.523 tCO_2/MWh Sorong grid 0.525 tCO_2/MWh In case the PV system(s) and storage battery system(s) in a proposed project activity are connected to an internal grid connecting to both a	systems in Indonesia and heat efficiency of the world's leading diesel generator. The default value is revised if deemed necessary by the JC.

	national/regional grid and a captive power generator (PV Case 2), EF_{RE} is set as follows: Jamali grid 0.533 tCO_2/MWh Sumatra grid 0.477 tCO_2/MWh Batam grid 0.533 tCO_2/MWh Tanjung Pinang, Tanjung Balai Karimun, Tanjung Batu, Kelong, Ladan, Letung, Midai, P Buru, Ranai, Sedanau, Serasan, and Tarempa grids 0.533 tCO_2/MWh Bangka, Belitung, S Nasik, and Seliu grids 0.533 tCO_2/MWh Khatulistiwa grid 0.532 tCO_2/MWh Barito grid 0.533 tCO_2/MWh Mahakam grid 0.527 tCO_2/MWh Tarakan grid 0.493 tCO_2/MWh Sulutgo grid 0.325 tCO_2/MWh Sulselbar grid 0.320 tCO_2/MWh Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids 0.533 tCO_2/MWh Palu Parigi grid 0.517 tCO_2/MWh Lombok, Bima, and Sumbawa grids 0.533 tCO_2/MWh Kupang, Ende, Maumere, and Waingapu grids 0.507 tCO_2/MWh Ambon, Tual, and Namlea grids 0.533 tCO_2/MWh Tobelo and Ternate Tidore grids 0.532 tCO_2/MWh Jayapura, Timika, and Genyem grids 0.523 tCO_2/MWh Sorong grid 0.525 tCO_2/MWh In case the PV system(s) and storage battery system(s) in a proposed project activity are connected to an internal grid which is not connected to a national/regional grid, and only connected to an isolated grid and/or a captive power generator (PV Case 3), EF_{RE}, 0.533 tCO_2/MWh is applied.	
$LR_{j,p}$	Loss ratio of charge and discharge on the project storage battery system *j* LR can be calculated by the following equation: $LR_{j,p} = 1 - \varphi_{charge,i,j,p} \times \varphi_{convert,i,j,p}$	Specifications of project storage battery system *j*

History of the document

Version	Date	Contents revised
01.0	28 November 2018	Electronic decision by the Joint Committee Initial approval.