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	Displacement of grid electricity and/or captive electricity by	
measures	installation and operation of solar PV system(s) and storage	
	battery system(s).	
Calculation of reference	Reference emissions are calculated on the basis of the amount of	
emissions	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	Project emissions are the emissions from the solar PV system(s)	
emissions	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.
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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 type		
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-CO₂/MWh for coal-fired power plant and 0.320 t-CO₂/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-CO₂/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 (tCO₂/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-CO₂/MWh is applied. The emission factors to be applied for PV Case 2 (t-CO₂/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 tCO₂/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:

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

RE_p : Reference emissions during the period p [tCO₂/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 CO₂ emission factor for the project system [tCO₂/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 [tCO₂/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 CO₂ emission factor for the project system [tCO₂/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 [tCO₂/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 CO₂ emission factor for the project system [tCO₂/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 [tCO₂/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 CO₂ emission factor for the project system [tCO₂/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 [tCO₂/p]

H. Calculation of emissions reductions

 $ER_p = RE_p \cdot PE_p$

 $= RE_p$

 ER_p : Emission reductions during the period p [tCO₂/p] RE_p : Reference emissions during the period p [tCO₂/p]

PE_p : Project emissions during the period p [tCO₂/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	The default emission
	system.	factor value is obtained
	The value for EF_{RE} is selected from the emission	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 sy co co po C

ystem(s) in a proposed project	activity are directly
onnected, or connected via a	n internal grid not
onnecting to either an isolated	d grid or a captive
ower generator, to a national	l/regional grid (PV
Case1), EF _{RE} is set as follows:	
Jamali grid	0.616 tCO ₂ /MWh

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Sumatra grid	0.477 tCO ₂ /MWh
Batam grid	0.664 tCO ₂ /MWh
Tanjung Pinang, Tanjung	0.555 tCO ₂ /MWh
Balai Karimun, Tanjung	
Batu, Kelong, Ladan, Letung,	
Midai, P Buru, Ranai,	
Sedanau, Serasan, and	
Tarempa grids	
Bangka, Belitung, S Nasik,	0.553 tCO ₂ /MWh
and Seliu grids	
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,	0.593 tCO ₂ /MWh
Lambuya, Wangi Wangi, and	
Raha grids	
Palu Parigi grid	0.517 tCO ₂ /MWh
Lombok, Bima, and	0.561 tCO ₂ /MWh
Sumbawa grids	
Kupang, Ende, Maumere,	0.507 tCO ₂ /MWh
and Waingapu grids	
Ambon, Tual, and Namlea	0.533 tCO ₂ /MWh
grids	
Tobelo and Ternate Tidore	0.532 tCO ₂ /MWh
grids	
Jayapura, Timika, and	0.523 tCO ₂ /MWh
Genyem grids	
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 The default generator. value is revised if deemed necessary by the JC.

(PV Case 2), EFRE is set as follows: Jamali grid 0.437 (CO ₂ /MWh Sumatra grid 0.477 (CO ₃ /MWh Tanjung Pinang, Tanjung Balai Karimun, Tanjung Batui, Kelong, Ladan, Letung, Midai, P Buru, Ranai, Sedanau, Serasan, and Tarempa grids Bangka, Belitung, S Nasik, and Seliu grids Khatulistiwa grid 0.533 (CO ₂ /MWh Barito grid 0.533 (CO ₂ /MWh Mahakam grid 0.532 (CO ₂ /MWh Sulutgo grid 0.333 (CO ₂ /MWh Sulutgo grid 0.325 (CO ₂ /MWh Sulutgo grid 0.325 (CO ₂ /MWh Sulusebar grid 0.320 (CO ₂ /MWh Sulusebar grid 0.320 (CO ₂ /MWh Kendari, Bau Bau, Kolaka, 0.533 (CO ₂ /MWh Lambuya, Wangi Wangi, and Raha grids Palu Parigi grid 0.517 (CO ₂ /MWh Lombok, Bima, and Sumbawa grids Kupang, Ende, Maumere, and 0.507 (CO ₂ /MWh Waingapu grids Ambon, Tual, and Namlea 0.533 (CO ₂ /MWh grids Tobelo and Ternate Tidore 0.532 (CO ₂ /MWh grids Jayapura, Timika, and Genyem 0.523 (CO ₂ /MWh grids Sorong grid 0.525 (CO 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), EFRE, 0.533 (CO ₂ /MWh is applied. LR _{1,0} Loss ratio of charge and discharge on the project storage battery system j LR can be calculated by the following equation:		national/regional grid and a capti	ive power generator	
Sumatra grid Batam grid Tanjung Pinang, Tanjung Balai Karimun, Tanjung Batu, Kelong, Ladan, Letung, Midai, P Buru, Ranai, Sedanau, Serasan, and Tarempa grids Bangka, Belitung, S Nasik, and Seliu grids Khatulistiwa grid Description Bario grid Sulutgo gr		(PV Case 2), EF _{RE} is set as follows:		
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Batam grid Tanjung Pinang, Tanjung Balai Karimun, Tanjung Batu, Kelong, Ladan, Letung, Midai, P Buru, Ranai, Sedanau, Serasan, and Tarempa grids Bangka, Belitung, S Nasik, and Seliu grids Khatulistiwa grid O.533 tCO2/MWh Barito grid O.533 tCO2/MWh Barito grid Mahakam grid O.527 tCO2/MWh Sulutgo grid O.523 tCO2/MWh Sulutgo grid O.523 tCO2/MWh Sulutgo grid O.525 tCO2/MWh Sulutgo grid O.533 tCO2/MWh Sulutgo grid O.533 tCO2/MWh Sulutgo grid O.533 tCO2/MWh Sulvapa grid O.533 tCO2/MWh Lambuya, Wangi Wangi, and Raha grids Palu Parigi grid O.517 tCO2/MWh Lombok, Bima, and Sumbawa grids Kupang, Ende, Maumere, and Waingapu grids Ambon, Tual, and Namlea O.533 tCO2/MWh grids Tobelo and Ternate Tidore O.532 tCO2/MWh grids Jayapura, Timika, and Genyem o.523 tCO2/MWh grids Sorong grid O.525 tCO2/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 tCO2/MWh is applied. LR _{3:p} Loss ratio of charge and discharge on the project storage battery system j				
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storage battery system j storage battery system j		Case 3), EF _{RE} , 0.533 tCO ₂ /MWh	is applied.	
	LR _{j,p}	Loss ratio of charge and discharge	arge on the project	Specifications of project
LR can be calculated by the following equation:		storage battery system j		storage battery system j
		LR can be calculated by the follow	wing equation:	
$LR_{j,p} = 1 - \varphi_{charge,i,j,p} \times \varphi_{convert,i,j,p}$		$LR_{j,p} = 1 - \varphi_{charge,i,j,p} \times \varphi_{conv}$	vert,i,j,p	

History of the document

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