Joint Crediting Mechanism Approved Methodology CL_AM002

"Installation of Solar PV System and Storage Battery System"

A. Title of the methodology

Installation of Solar PV System and Storage Battery System, Version 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.
Energy Management System (EMS)	A computer-based system which monitors, controls, and optimizes the amount of electricity supplied.

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), the storage battery system(s), and EMS which are

	assumed to be zero.
Monitoring parameters	The quantity of the electricity generated by the project solar PV system(s), the quantity of the net electricity which the project EMS supplies to the regional grid or captive power generator which is displaced by the project solar PV system, 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 or installed to replace existing storage battery system(s).
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 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 one 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
Consumption of electricity by storage battery system(s)	N/A
Consumption of electricity by EMS	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 Chilean regional grids: the National Electricity System (SEN), the Aysén system, and the Magallanes system.

The emission factor is calculated based on the conservative operating margin that reflects on the latest electricity mix including low cost/must run resources for each regional grid in Chile during 2016-2018 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 is calculated to be 0.826 tCO_2/MWh for coal-fired power plant and 0.364 tCO_2/MWh for gas-fired power plant based on the survey on heat efficiency of power plant in Chile. The emission factor for diesel power plant is calculated to be 0.533 tCO_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 solar PV system(s) in a proposed project activity is directly connected or connected via an internal grid, not connecting to a captive power generator, to a regional grid (PV Case 1), the value of operating margin including LCMR resources, using the best heat efficiency among currently operational plants in Chile in calculating emission factors of fossil fuel power plants, is applied. The emission factors to be applied in this case are shown as "PV Case 1" in section I of this methodology.

In the case the solar PV system(s) in a proposed project activity is connected to an internal grid connecting to both a regional grid and a captive power generator (PV Case 2), the lower value between emission factors shown as "PV Case 1" in section I of this methodology and the conservative emission factor of diesel-fired power plant of 0.533 tCO_2/MWh is applied. The emission factors to be applied in this case are shown as "PV Case 2" in section I of this methodology.

In the case that the solar PV system(s) in a proposed project activity is connected to an internal grid only connecting to a captive power generator (PV Case 3), the emission factor of a diesel generator calculated by applying the heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel generator, which is set to 0.533 tCO_2/MWh, is applied.

The emission factors to be applied in each case are shown in Section I. Data and parameters fixed ex ante of this methodology.

F.2. Calculation of reference emissions

For calculation of reference emissions, either Option1, Option2, Option3-1, Option3-2 or Option4 is selected in line with the monitoring parameters which can be monitored.

Option1:

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

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 : Loss ratio of charge and discharge on the project storage battery system *j* [-]
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:

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

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 : Loss ratio of charge and discharge on the project storage battery system *j* [-]
EF_{RE} : Reference CO_2 emission factor for the project system [tCO_2/MWh]

Option3-1 (In case the project storage battery system(s) is 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) is charged by electricity sources including the project solar PV system(s)):

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

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]

$EC_{i,j,p}$: 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]

Option4 (In case an EMS manages the quantities of electricity which the project solar PV system(s) supplies to the EMS, electricity which the EMS charges the project storage battery system(s), electricity which the project storage battery system(s) discharges to the EMS and electricity which the EMS supplies to the electricity system displaced by the project):

$$RE_p = \sum_{i,k} NEG_{i,k,p} \times EF_{RE}$$

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

$NEG_{i,k,p}$: Quantity of the net electricity which the project EMS *k* supplies to the regional grid or captive power generator which is displaced by the project solar PV system *i* during

the period *p* [MWh/p]

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

k : Identification number of the project EMS

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 emission factor of the regional grid and/or captive power generator which is displaced by the project solar PV system. The value for EF_{RE} is selected from the list of emission factors in the following manner: <u>PV Case 1:</u> In case the solar PV system(s) in a proposed project activity is connected to a regional grid including through internal grid which is not connected to a captive power generator, EF_{RE} is set	The default emission factor is obtained from a study of electricity systems in Chile and the most efficient diesel power generator (49% heat efficiency). The default value is revised if deemed

	as follows per the connected regional grid: Regional grid name: Emission factor for PV Case 1: SEN (National System) 0.404 tCO_2/MWh Aysén System 0.176 tCO_2/MWh Magallanes System 0.361 tCO_2/MWh <u>PV Case 2:</u> In case the solar PV system(s) in a proposed project activity is connected to an internal grid connected to both a regional grid and a captive power generator, EF_{RE} is set as follows per the connected regional grid: Regional grid name: Emission factor for PV Case 2: SEN (National System) 0.404 tCO_2/MWh Aysén System 0.176 tCO_2/MWh Magallanes System 0.361 tCO_2/MWh <u>PV Case 3:</u> In case the solar PV system(s) in a proposed project activity is connected to an internal grid which is not connected to the regional grid, EF_{RE} is set at 0.533 tCO_2/MWh.	necessary by the JC.
LR_j	Loss ratio of charge and discharge on the project storage battery system *j* LR can be calculated by the following equation: $LR_j = 1 - \varphi_{charge,j} \times \varphi_{convert,j}$ $\varphi_{charge,j}$: Charging efficiency of the project storage battery system *j* [-] $\varphi_{convert,j}$: Conversion efficiency of project storage battery system *j* [-]	Specifications of project storage battery system *j*

History of the document

Version	Date	Contents revised
01.0	4 December 2020	Electronic decision by the Joint Committee Initial approval.