JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	Republic of Maldives
Name of the methodology proponents submitting this form	Nippon Koei Co., Ltd.
Sectoral scope(s) to which the Proposed Methodology applies	1. Energy industries (renewable / non-renewable sources)
Title of the proposed methodology, and version number	Installation of Energy Management System and Battery Energy Storage System (EMS-BESS) with Solar PV System, Ver 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information
Date of completion	23/06/2020

History of the proposed methodology

Version	Date	Contents revised
01.0	23/06/2020	First edition

A. Title of the methodology

Installation of Energy Management System and Battery Energy Storage System (EMS-BESS) with Solar PV 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).
Energy Management System (EMS)	The EMS is a system composed of server and software which can forecast the electricity load and PV generation and to conduct Economic Load Dispatching Control by controlling the thermal power such as diesel generator(s) (DG) and Battery Energy Storage System (BESS) for efficient system operation.
Battery Energy Storage System (BESS)	The BESS is a system consisted of power converter(s) and connected group of battery cell which charges and discharges itself by converting electrical energy into chemical energy. The BESS is controlled by EMS for efficient charging and discharging.
Diesel Generator (DG)	The DG is an electricity generator which uses diesel oil. Most of the electricity in Maldives is generated by DG. The efficiency of the DG is high in 80-100% load and decreases in the lower load range.

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), EMS and

	BESS.
Calculation of reference emissions	Reference emissions are calculated on the basis of the amount of the electricity displaced by the project by the conservative emission factor of the grid and captive electricity.
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).

D. Eligibility criteria

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

Criterion 1	EMS and BESS are newly installed to a grid and/or captive electricity which is sourced at least from, but not limited to both thermal power such as diesel generator(s) and solar PV system(s). Solar PV system(s) may be newly installed together with EMS and BESS.
Criterion 2	Installed EMS is equipped with economic load dispatching control function and load frequency control which controls diesel generators and BESS based on projections of electric-load/demand and output of solar PV system(s).
Criterion 3	The equipment to monitor output power of the solar PV system(s) is installed at the project site.
Criterion 4	Data of fuel consumption and fuel consumed before activation of EMS and BESS is available for each DG in the power station. The data is to be collected monthly for at least one year.
Criterion 5	In case the PV modules are newly installed, they need to be certified for design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2).
Criterion 6	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

Being an island country, almost all the islands generate its own electricity mainly by diesel generators (DG) and all grids in the Maldives are isolated.

It is studied that without EMS-BESS, the efficiency of DG connected to mini-grids in the Maldives is decreased after the installation of solar PV system by 1) lower load operation of the DG and 2) absorption of solar fluctuation by the DG. In addition, 3) EMS and BESS can operate the DG at the most efficient load by the Economic Load Dispatching Control.

This methodology evaluates the improvement of the efficiency of DG by the contribution of EMS-BESS as above by setting the different emission factor from MV_AM001 which considers only PV installation.
To ensure the net emission reductions, the best efficiency among the installed DG in the grid is adopted to calculate the emission factor of the grid. The best efficiency is calculated from the record of generated power (kWh) and consumed fuel (liter) taken from the production report of electricity company or power producer (at least one year data). When available, recorded data before the installation of solar PV system(s) in the grid are applied.

F.2. Calculation of reference emissions

$$RE_p = \sum_i EG_{i,p} \times EF_{RE}$$

RE_p : Reference emissions during the period *p* [tCO_2/p]
$EG_{i,p}$: The quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

EF_{RE} : The reference CO_2 emission factor of grid and captive electricity [tCO_2/MWh]

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}	The reference CO_2 emission factor of grid and captive electricity, calculated based on the actual efficiency of the most efficient DG connected.	Additional information The default emission factor is derived from the result of the survey on the actual efficiency of the most efficient DG connected to the grid. The actual efficiency is set based on the data for at least one year. The emission factor is equal to or less than 0.8 t-CO_2/MWh.