

**Joint Crediting Mechanism Approved Methodology MN\_AM003**  
**“Installation of Solar PV System”**

**A. Title of the methodology**

Installation of Solar PV System, Ver. 024.0

**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).

**C. Summary of the methodology**

Items	Summary
<i>GHG emission reduction measures</i>	Displacement of grid electricity and/or captive electricity by installation and operation of solar PV system(s).
<i>Calculation of reference emissions</i>	Reference emissions are calculated on the basis of the AC output of the solar PV system(s) multiplied by either; 1) the conservative emission factor of the grid, or 2) conservative emission factor of diesel power generator.
<i>Calculation of project emissions</i>	Project emissions are the emissions from the solar PV system(s), which are assumed to be zero.
<i>Monitoring parameters</i>	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.

<b>Criterion 1</b>	The project newly installs solar PV system(s).
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Criterion 2	The PV modules obtained a certification of design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2).
Criterion 3	The equipment used to monitor output power of the solar PV system(s) and irradiance is installed at the project site.

## E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Consumption of grid electricity and/or captive electricity	CO <sub>2</sub>
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 factors are set in a conservative manner based on the Mongolian national grid which consists of Central Energy System (CES), Altai-Uliastai Energy System (AUES), Western Energy System (WES), Eastern Energy System (EES), and Southern (Gobi) Energy System (SES) and based on the most efficient heat efficiency of a diesel power generator.

In order to identify the emission factor based on the national grid simplistically and secure net emission reductions, this methodology applies the lowest emission factor of coal-fired power plant supplying electricity to the national grid, which is set to be 0.797 tCO<sub>2</sub>/MWh. This value is lower than the grid emission factor for CES, which is 1.154 tCO<sub>2</sub>/MWh (combined margin, 2012) published by Mongolian government, and it ensures net emission reductions.

In addition, the conservative emission factor based on a captive diesel power generator is calculated by applying the default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel power generator, and set to 0.533 tCO<sub>2</sub>/MWh.

### F.2. Calculation of reference emissions

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

$RE_p$  : Reference emissions during the period  $p$  [tCO<sub>2</sub>/p]

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

$EF_{RE,i}$  : Reference CO<sub>2</sub> emission factor for the project solar PV system  $i$  [tCO<sub>2</sub>/MWh]

## G. Calculation of project emissions

Project emissions are not assumed in the methodology as electricity consumption by any PV system is negligible.

$$PE_p = 0$$

$PE_p$  : Project emissions during the period  $p$  [tCO<sub>2</sub>/p]

## H. Calculation of emissions reductions

$$\begin{aligned} ER_p &= RE_p - PE_p \\ &= RE_p \end{aligned}$$

$ER_p$  : Emission reductions during the period  $p$  [tCO<sub>2</sub>/p]

$RE_p$  : Reference emissions during the period  $p$  [tCO<sub>2</sub>/p]

$PE_p$  : Project emissions during the period  $p$  [tCO<sub>2</sub>/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
$EF_{RE,i}$	Reference CO <sub>2</sub> emission factor for the project solar PV system $i$ .  The value for $EF_{RE,i}$ is selected from the emission factor based on the national grid ( $EF_{RE,grid}$ ) or based on	Additional information  The default emission factors are derived from a study of electricity systems in

	<p>captive diesel power generator (<math>EF_{RE, cap}</math>) in the following manner:</p> <p>In case the PV system in a proposed project activity is connected to the national grid (CES, WES, AUES, EES, and/or SES) including internal grid which is not connected to a captive power generator, <math>EF_{RE, grid}</math>, 0.797 tCO<sub>2</sub>/MWh is applied.</p> <p>In case the PV system in a proposed project activity is connected to internal grid which is connected to both the national grid (CES, WES, AUES, EES, and/or SES) and a captive power generator, <math>EF_{RE, cap}</math>, 0.533 tCO<sub>2</sub>/MWh is applied.</p> <p>In case the PV system in a proposed project activity is connected to internal grid which is not connected to the national grid, <math>EF_{RE, cap}</math>, 0.533 tCO<sub>2</sub>/MWh is applied.</p>	<p>Mongolia and the default heat efficiency of 49% which is set above the value of the most efficient diesel power generator. The default value is revised if deemed necessary by the JC.</p>
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## History of the document

Version	Date	Contents revised
<u>02.0</u>	<u>30 January 2017</u>	<p><u>Revision to:</u></p> <ul style="list-style-type: none"> <li>● <u>Change the description of "Measurement methods and procedures" to clarify the requirement for calibration in the Monitoring Spreadsheet: JCM_MN_AM003.</u></li> </ul>
01.0	29 September 2016	JC4, annex 1 Initial approval.

**Monitoring Plan Sheet (Input Sheet) [Attachment to Project Design Document]**

**Table 1: Parameters to be monitored *ex post***

(a) Monitoring point No.	(b) Parameters	(c) Description of data	(d) Estimated Values	(e) Units	(f) Monitoring option	(g) Source of data	(h) Measurement methods and procedures	(i) Monitoring frequency	(j) Other comments
(1)	EG <sub>i,p</sub>	Quantity of the electricity generated by the project solar PV system <i>i</i> during the period <i>p</i>	0	MWh/p	Option B/C	Invoice or receipts/ Measured data	Invoice or receipts for selling electricity, or the <b>measured</b> AC output of the inverters is <b>measured</b> used to determine the amount of net electricity generation by the solar PV system. <b>In case the measured AC output of the inverters is used, the</b> reading is taken from an electricity meter or the inverters. The reading is taken manually or electronically using a data logger. <del>The electricity meter is certified by an entity accredited under international/national standards. The electricity meter is replaced or calibrated tested for accuracy at an interval following the regulations in the country in which the electricity meter is commonly used or according to the manufacturer's recommendation, unless the electricity meter has obtained a type approval, manufacturer's specification, or certification issued by an entity accredited under international/national standards for the electricity meter has been prepared by the time of installation. The electricity meter is calibrated or replaced when it fails to pass the test.</del>	Monthly recording	Input on "MPS(input_separate)" sheet

**Table 2: Project-specific parameters to be fixed *ex ante***

(a) Parameters	(b) Description of data	(c) Estimated Values	(d) Units	(e) Source of data	(f) Other comments
EF <sub>RE,i</sub>	Reference CO <sub>2</sub> emission factor for the project solar PV system <i>i</i>		- tCO <sub>2</sub> /MWh	<p>In case the PV system in a proposed project activity is connected to the national grid (CES, WES, AUES, EES, and/or SES) including through internal grid which is not connected to a captive power generator, EF<sub>RE,grid</sub>, 0.797 tCO<sub>2</sub>/MWh is applied.</p> <p>In case the PV system in a proposed project activity is connected to internal grid which is connected to both the national grid (CES, WES, AUES, EES, and/or SES) and a captive power generator, EF<sub>RE,cap</sub>, 0.533 tCO<sub>2</sub>/MWh is applied.</p> <p>In case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, EF<sub>RE,cap</sub>, 0.533 tCO<sub>2</sub>/MWh is applied.</p>	Input on "MPS(input_separate)" sheet

**Table 3: *Ex-ante* estimation of CO<sub>2</sub> emission reductions**

CO <sub>2</sub> emission reductions	Units
0	tCO <sub>2</sub> /p

**[Monitoring option]**

Option A	Based on public data which is measured by entities other than the project participants (Data used: publicly recognized data such as statistical data and specifications)
Option B	Based on the amount of transaction which is measured directly using measuring equipments (Data used: commercial evidence such as invoices)
Option C	Based on the actual measurement using measuring equipments (Data used: measured values)

	Parameters to be monitored <i>ex post</i>	Project-specific parameters to be fixed <i>ex ante</i>
<i>i</i>	$EG_{i,p}$	$EF_{RE,i}$
Solar PV system number	Quantity of the electricity generated by the project solar PV system <i>i</i> during the period <i>p</i> MWh/p	Reference CO <sub>2</sub> emission factor for the project solar PV system <i>i</i> tCO <sub>2</sub> /MWh
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**Monitoring Plan Sheet (Calculation Process Sheet) [Attachment to Project Design Document]**

1. Calculations for emission reductions	Fuel type	Value	Units	Parameter
Emission reductions during the period $p$	N/A	0	tCO <sub>2</sub> /p	ER <sub>p</sub>
2. Selected default values, etc.				
The reference CO <sub>2</sub> emission factor of electricity				
The reference CO <sub>2</sub> emission factor based on the national grid	Mixed	0.797	tCO <sub>2</sub> /MWh	EF <sub>RE,grid</sub>
The reference CO <sub>2</sub> emission factor based on the captive power generator	Diesel	0.533	tCO <sub>2</sub> /MWh	EF <sub>RE,cap</sub>
3. Calculations for reference emissions				
Reference emissions during the period $p$	N/A	0	tCO <sub>2</sub> /p	RE <sub>p</sub>
4. Calculations of the project emissions				
Project emissions during the period $p$	N/A	0	tCO <sub>2</sub> /p	PE <sub>p</sub>

## [List of Default Values]

The reference CO <sub>2</sub> emission factor based on the national grid (GES, WES, AUES, EES, SES)	Mixed	0.797
The reference CO <sub>2</sub> emission factor based on the captive power generator	Diesel	0.533

**Monitoring Structure Sheet [Attachment to Project Design Document]**

Responsible personnel	Role

**Monitoring Report Sheet (Input Sheet) [For Verification]**

**Table 1: Parameters monitored ex post**

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Monitoring period	Monitoring point No.	Parameters	Description of data	Monitored Values	Units	Monitoring option	Source of data	Measurement methods and procedures	Monitoring frequency	Other comments
	(1)	EG <sub>i,p</sub>	Quantity of the electricity generated by the project solar PV system <i>i</i> during the period <i>p</i>	0	MWh/p	Option B/C	Invoice or receipts/ Measured data	Invoice or receipts for selling electricity, or the <b>measured</b> AC output of the inverters is <del>measured</del> used to determine the amount of net electricity generation by the solar PV system. <b>In case the measured AC output of the inverters is used, the</b> reading is taken from an electricity meter or the inverters. The reading is taken manually or electronically using a data logger. <del>The electricity meter is certified by an entity accredited under international/national standards. The electricity meter is replaced or calibrated tested for accuracy at an interval following the regulations in the country in which the electricity meter is commonly used or according to the manufacturer's recommendation, unless the electricity meter has obtained a type approval, manufacturer's specification, or certification issued by an entity accredited under international/national standards for the electricity meter has been prepared by the time of installation. The electricity meter is calibrated or replaced when it fails to pass the test.</del>	Monthly recording	Input on "MRS(input_separate)" sheet

**Table 2: Project-specific parameters fixed ex ante**

(a)	(b)	(c)	(d)	(e)	(f)
Parameters	Description of data	Estimated Values	Units	Source of data	Other comments
EF <sub>RE,i</sub>	Reference CO <sub>2</sub> emission factor for the project solar PV system <i>i</i>		- tCO <sub>2</sub> /MWh	In case the PV system in a proposed project activity is connected to the national grid (CES, WES, AUES, EES, and/or SES) including through internal grid which is not connected to a captive power generator, EFRE <sub>grid</sub> , 0.797 tCO <sub>2</sub> /MWh is applied. In case the PV system in a proposed project activity is connected to internal grid which is connected to both the national grid (CES, WES, AUES, EES, and/or SES) and a captive power generator, EFRE <sub>cap</sub> , 0.533 tCO <sub>2</sub> /MWh is applied. In case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid, EFRE <sub>cap</sub> , 0.533 tCO <sub>2</sub> /MWh is applied.	Input on "MPS(input_separate)" sheet

**Table3: Ex-post calculation of CO<sub>2</sub> emission reductions**

Monitoring Period	CO <sub>2</sub> emission reductions	Units
	0	tCO <sub>2</sub> /p

**[Monitoring option]**

Option A	Based on public data which is measured by entities other than the project participants (Data used: publicly recognized data such as statistical data and specifications)
Option B	Based on the amount of transaction which is measured directly using measuring equipments (Data used: commercial evidence such as invoices)
Option C	Based on the actual measurement using measuring equipments (Data used: measured values)

	Parameters to be monitored <i>ex post</i>	Project-specific parameters to be fixed <i>ex ante</i>
i	EG <sub>i,p</sub>	EF <sub>RE,i</sub>
Solar PV system number	Quantity of the electricity generated by the project solar PV system <i>i</i> during the period <i>p</i> MWh/p	Reference CO <sub>2</sub> emission factor for the project solar PV system <i>i</i> tCO <sub>2</sub> /MWh
1		0.000
2		0.000
3		0.000
4		0.000
5		0.000
6		0.000
7		0.000
8		0.000
9		0.000
10		0.000
11		0.000
12		0.000
13		0.000
14		0.000
15		0.000
16		0.000
17		0.000
18		0.000
19		0.000
20		0.000
21		0.000
22		0.000
23		0.000
24		0.000
25		0.000
26		0.000
27		0.000
28		0.000
29		0.000
30		0.000
31		0.000
32		0.000
33		0.000
34		0.000
35		0.000
36		0.000
37		0.000
38		0.000
39		0.000
40		0.000
41		0.000
42		0.000
43		0.000
44		0.000
45		0.000
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94		0.000
95		0.000
96		0.000
97		0.000
98		0.000
99		0.000
100		0.000

**Monitoring Report Sheet (Calculation Process Sheet) [For Verification]**

1. Calculations for emission reductions	Fuel type	Value	Units	Parameter
Emission reductions during the period $p$	N/A	0	tCO <sub>2</sub> /p	ER <sub>p</sub>
2. Selected default values, etc.				
The reference CO <sub>2</sub> emission factor of electricity				
The reference CO <sub>2</sub> emission factor based on the national grid	Mixed	0.797	tCO <sub>2</sub> /MWh	EF <sub>RE,grid</sub>
The reference CO <sub>2</sub> emission factor based on the captive power generator	Diesel	0.533	tCO <sub>2</sub> /MWh	EF <sub>RE,cap</sub>
3. Calculations for reference emissions				
Reference emissions during the period $p$	N/A	0	tCO <sub>2</sub> /p	RE <sub>p</sub>
4. Calculations of the project emissions				
Project emissions during the period $p$	N/A	0	tCO <sub>2</sub> /p	PE <sub>p</sub>

## [List of Default Values]

The reference CO <sub>2</sub> emission factor based on the national grid (GES, WES, AUES, EES, SES)	Mixed	0.797
The reference CO <sub>2</sub> emission factor based on the captive power generator	Diesel	0.533