Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the project activity	5MW Thap Sakae Photovoltaic Solar Cell Power Plant Project, Thailand	
UNFCCC reference number of the project activity	10194	
Version number of the PDD applicable to this monitoring report	08[1]	
Version number of this monitoring report	06	
Completion date of this monitoring report	19/01/2018	
Monitoring period number	Monitoring Period 01	
Duration of this monitoring period	Duration: 01/08/2016 – 31/03/2017 (first and last days are included)	
Monitoring report number for this monitoring report	01	
Project participants	Electricity Generating Authority of Thailand	
Host Party	Thailand	
Sectoral scopes	Sectoral scope 01: Energy industries (renewable sources / non-renewable resources)	
Applied methodologies and standardized baselines	AMS-I.D – "Grid connected renewable electricity generation" (Version 18, Sectoral scope 01, EB 81)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	-	1,788 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	2,412 tCO_2e	

[1] Revised version of PDD due to changes after project registration

SECTION A. Description of project activity

A.1. General description of project activity

>> "5MW Thap Sakae Photovoltaic Solar Cell Power Plant Project, Thailand" (hereafter called the "project") is developed by Electricity Generating Authority of Thailand (hereafter called the "EGAT"). The project activity is a construction and operation of a new solar photovoltaic (PV) power plant at Prachuap Khiri Khan Province in Thailand. The project installed 4 types of solar photovoltaic module which are Crystalline Silicon: c-Si, Amorphous Silicon: a-Si, Copper Indium (Gallium) Di-Selenide: Cl(G)S and Micro Crystalline Amorphous Silicon: µc/a-Si. The total capacity of the power plant is 5 $MW_{(AC)}$. The scenario existing prior to the project activity implementation is only an abandon coconut plantation area where is no any other power plants existed (this is a Greenfield project).

The purpose of this project is to generate clean electricity by utilizing solar energy and to reduce the greenhouse gas (GHG) emissions by displacing equivalent amount of electricity from carbon intensive the national grid. The project activity involves generation of electricity by utilizing the available solar energy and exporting it to the Thai National Grid. By displacing the fossil fuel based grid electricity, the total emission reduction achieved in this monitoring period is 1,788 tCO_2e.

The relevant dates for the project activity shown in Table 1 below;

Table 1: Relevant date for project activity

Event	Date	Evidence
EGAT signed the Engineering Procurement and Construction contract (EPC)	08/05/2014	EPC
EGAT started exporting electricity to Thai national grid (start date of operation)	24/08/2016	First sync report

A.2. Location of project activity

>> **Host Party: Thailand**

Region/State/Province: Prachaup Khiri Khan Province

City/Town/Community etc.:Thap Sakae District

Physical/Geographical Location: The project site is situated in Thap Sakae District, Prachuap Khiri Khan Province in Thailand. The total site area available for this project is approximately 250 rai. The co-ordinates of each corner of the project site are (11°28'31.52"N Latitude, 99°35'41.62"E Longitude), (11°28'21.90"N Latitude, 99°35'39.33"E Longitude), (11°28'10.62"N Latitude, 99°36'0.87"E Longitude) and (11°28'29.92"N Latitude, 99°36'1.69"E Longitude).The central point of the project activity is located at 11°28'21.60"N Latitude 99°35'52.54"E Longitude.

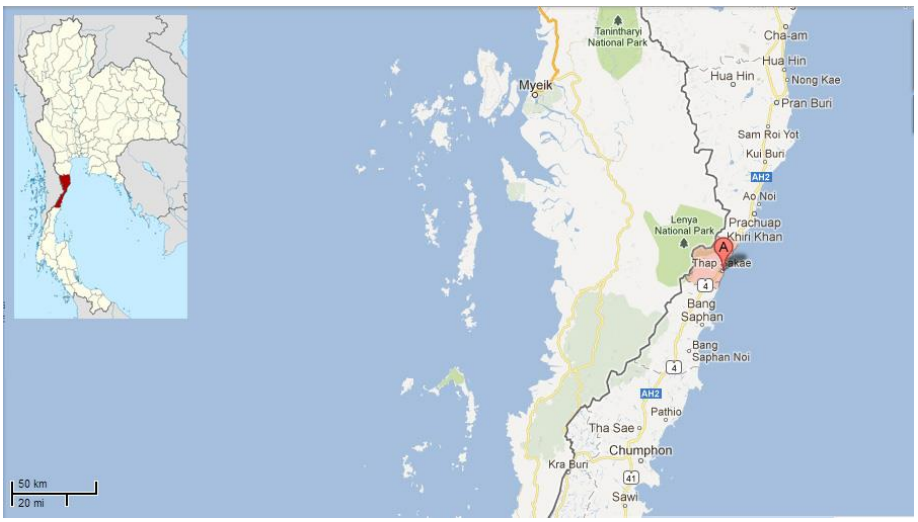

Figure 1: Map of Thap Sakae district in Prachuap Khiri Khan province, Thailand

Figure 2: Aerial photograph of the project location in Thap Sakae district, Prachuap Khiri Khan Province.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (host)	Electricity Generating Authority of Thailand	No

A.4. Reference to applied methodologies and standardized baselines

>> AMS-I.D – "Grid connected renewable electricity generation" (Version 18, Sectoral scope 01, EB 81)[2]

[2] AMS-I.D – Grid connected renewable electricity generation (Version 18) https://cdm.unfccc.int/UserManagement/FileStorage/2P7FS6ZQAR84LG3NMKYUH50WI9ODBC

A.5. Crediting period type and duration

>> Type of crediting period: Fixed crediting period
Starting date of the crediting period: 01/08/2016
Length of the crediting period corresponding to this monitoring period: 8 months from 01/08/2016 - 31/03/2017

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

>> The project activity applied the Solar Photovoltaic (PV) technology imported from oversea and thus is a case of technology transfer to Thailand. The technology is sound and environmentally safe because it does not produce any GHGs during its operation.

Solar photovoltaic systems convert sunlight into electricity. Solar photovoltaic cells employ special materials called semiconductors that produce electricity when exposed to sunlight. Like most of the semiconductor devices, solar photovoltaic cells include also a positive layer (at the bottom) and a negative layer (on the top) that create an electrical field inside the cell. When a photon of light strikes a semiconductor, it releases electrons. The free electrons flow through the solar cell's bottom layer to a connecting wire as direct current (DC).

In addition to modules, several components such as inverters, transformers, etc. are needed to complete a solar photovoltaic power plant. These power plants incorporate inverters or power control units to transform the DC produced by the solar photovoltaic cells into alternating current (AC). Only then, the electricity is supplied to the national grid. Complete systems usually include safety disconnects, fuses and a grounding circuit as well.

The schematic diagram of the grid connected solar PV power plant is given in the following figure:

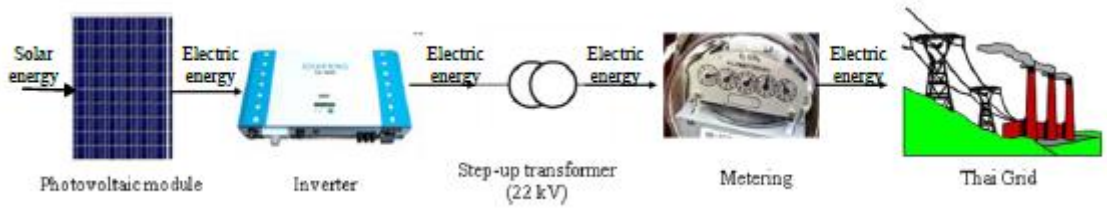

Figure 3: Schematic diagram of solar PV power plant

Photovoltaic module

A photovoltaic module or photovoltaic panel is a packaged, interconnected assembly of photovoltaic cells. Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The structural (load carrying) member of a module can either be the top layer or the bottom layer. The conducting wires that take the current off the panels may contain silver, copper or other conductive (but generally non- magnetic) transition metals. The project applies 4 PV technologies as below;

Table 2: PV module specification

No.	Photovoltaic module type	Quantity ($MW_{(AC)}$)	Quantity (Cell)	Nominal peak (Wp)
1	Crystalline Silicon: c-Si	1	5,016	250
2	Amorphous Silicon: a-Si	2	40,000	65
3	Copper Indium (Gallium) Di-Selenide: Cl(G)S	1	10,880	115
4	Micro Crystalline Amorphous Silicon: µc/a-Si	1	9,792	130

Inverter

An inverter is an electrical device that converts direct current (DC) into alternating current (AC). The converted AC can be obtained at any required voltage and frequency by using appropriate transformers, switching and control circuits.

Table 3: Inverter specification

Inverter Capacity	Quantity
630 kW Inverter	10

Step-up transformer

Step-up transformers are devices which increase the voltage of the incoming current. These are typically used before interconnecting with the grid.

Table 4: Transformer specification

No.	Transformer Capacity	Quantity	Output/Input
1	1,250 KVA	5	22 KV/315 V
2	200 KVA	1	22 KV/400 V

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

>> During this monitoring period, there are no any temporary deviations from registered monitoring plan or applied methodology.

B.2.2. Corrections

>> During this monitoring period, there are no any correction from registered monitoring plan or applied methodology.

B.2.3. Changes to the start date of the crediting period

>> The actual start date of crediting period is 01/08/2016

B.2.4. Inclusion of monitoring plan

>> During this monitoring period, there are no any inclusion that was not included at registration.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>> According to the actual project implementation in this monitoring period, there are the permanent changes to the registered monitoring plan as details below

1) The accuracy class of import electricity meter has been changed from 0.5s to 0.2s. In the actual project implementation, the import electricity meters have been operated and maintained by EGAT instead of PEA because a higher accuracy meter and meter calibration frequency can be controlled by EGAT.
2) The QA/QC procedure of parameter $EG_{PJ,export,y}$ has been changed to "Meter was calibrated periodically as per national standard by accredited person or institution or EGAT. Data measured will be crosschecked by power delivery report issued by EGAT monthly."
3) The QA/QC procedure of parameter $EG_{PJ,import,y}$ has been changed to "Meter was calibrated periodically as per national standard by accredited person or institution or EGAT. Data measured will be crosschecked by electricity invoice from PEA monthly."

Such changes are falling under category "(c) Changes that are being submitted with this monitoring report as part of the request for issuance (post-registration change - issuance track) as applicable from this monitoring period."

The changes have been revised to the PDD (date of completion 28/11/2017) and the Post-registration Change Validation report (date of completion 03/01/2018)

B.2.6. Changes to project design

>> During this monitoring period, there is change to project design due to the installation of units with lower capacity the installation. The number of photovoltaic panel, Crystalline Silicon: c-Si has been changed in the actual project implementation from 5,040 to 5,016 cells.

Such change is falling under category "(c) Changes that are being submitted with this monitoring report as part of the request for issuance (post-registration changes - issuance track) as applicable from this monitoring period."

The change of project design has been revised to the PDD (date of completion 28/11/2017) and the Post-registration Change Validation report (date of completion 03/01/2018)

SECTION C. Description of monitoring system

>> **Composition of CDM monitoring team**

EGAT is well aware of the importance of having a good operational and management team in order to execute a well-defined monitoring plan for the project activity. So, it has an operational and management structure created exclusively for monitoring the relevant plant parameters. The responsibilities of data monitoring, archiving and analyzing will be managed by members of the monitoring team.
The CDM monitoring team comprises of the following members:

- Plant manager
- Project consultant or Technical support team
- Operation team

The responsibilities of each of the CDM monitoring team member are as follows:

Plant manager:

- Supervision all the monitoring activities

Project consultant or Technical support team:

- Checking the data and taking measures for ensuring precision of the meters.
- Ensuring monthly reading and monthly testing on a regular basis.
- Ensuring that the erroneous measurements are detected and reported by any employee involved in the implementation of monitoring plan

Operation team:

- Reading, recording, handling, reporting and archiving relevant data.
- Maintaining a daily log for issues related to power generation

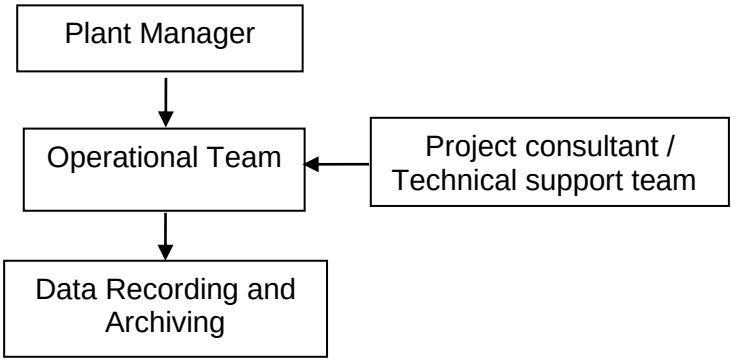

Figure 4: Planned operational and management structure for monitoring

Under the supervision of the Plant Manager, the monitoring and archiving are carried out by the operational team. All the data is recorded according to the data archiving procedures and stored electronically in a systematic and transparent manner. The Plant Manager will review the archived data. This data will be verified again by an external independent Designated Operational Entity (DOE) annually.

Data logging, presentation and storing

EGAT monitored the quantity of electricity exported to the grid and imported to the project activity using the electricity meters installed in the solar power plant, which undertaken by EGAT. Both electricity meters were measured the amount of electricity continuously and record electronically. The plant operator also manually recorded amount of the electricity import and export meter to the grid from meters in the log book monthly. The monitoring reports were checked and discussed periodically.

'Daily operation and maintenance log books' were kept at the project site and maintained by responsible operators. The responsible persons provided detailed on-the-spot information about the operation of the plant. Any distinguishing event was reported and recorded as special log. Data measured was crosschecked by monthly power delivery reports and electricity invoices.

All monitored data have to store at least two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

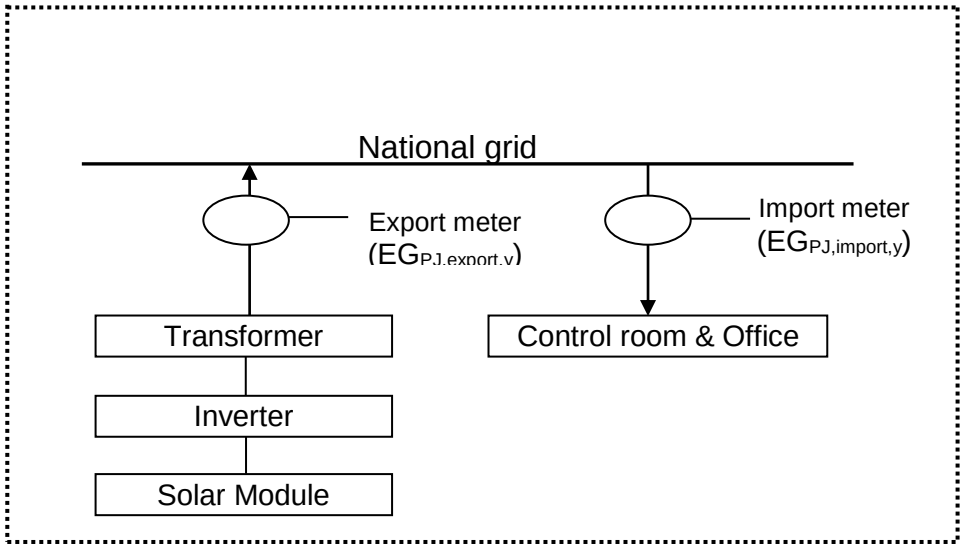

Figure 5: Monitoring diagram

Quality assurance and quality control

The meters installed in the solar power plant to monitor imported and exported electricity in the project activity are undertaken by EGAT and take responsibility in calibration and overall maintenance on a regular basis at least once in 3 years throughout the crediting period in accordance with the national/international standards. In case of EGAT cannot calibration the electricity meter in accordance with the national/international standards (at least once in 3 years) due to any reason, the meters will calibrated by an accredited person or institution. EGAT will take responsibility in recording and archiving the data by appointing consultants and/or technical support team. EGAT will also provide sufficient number of staff for data collection and monitoring and necessary training in order to improve the efficiency of their work. In case that the responsibility for monitoring is transferred to another person, it needs to be approved by the power plant manager.

Operation and Maintenance

EGAT would check the healthiness of the meters by checking indicator lamps or by taking readings as frequently as possible. If meters are found to be defective, it would be tested and calibrated immediately. The defective meters will be replaced immediately by a new meter. Operation team would take corrective active if meters are found not working. In case that the meters are malfunction, the operator will repair the meter soonest and then will fix or replace with a new meter after getting notification.

Emergency procedure

In case of emergency that the monitoring equipment has a problem, the operator will repair the meter soonest and then will fix or replace with a new meter after getting notification. During emergency situation, monitoring data from backup meter will be used for calculation of emission reduction. In case loss of monitoring data from both main and backup meter at the same time, the emission reduction will not be claimed during this period

Training

All the relative staff will be trained before operation of the PV power plants by PP's representative. The training consists of CDM knowledge, operational regulations, quality control (QC), data monitoring requirements and data management regulations, etc.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	$FC_{i,y}$
Unit	Mass or volume unit
Description	Amount of fossil fuel type i consumed in the project electricity system in year y
Source of data	Energy Policy&Planning Office (EPPO), Ministry of Energy.
Value(s) applied	Refer to Appendix 4 of register PDD
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit
Description	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data	Thailand energy efficiency situation 2013/ Department of Alternative Energy Development and Efficiency, Ministry of Energy
Value(s) applied	Refer to Appendix 1
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$EF_{CO2,i,y}$
Unit	t CO_2/GJ
Description	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the *"2006 IPCC Guidelines on National GHG Inventories"*
Value(s) applied	Refer to Appendix 4 of register PDD
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	EG_y
Unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must run power plants/units, in year *y*
Source of data	Energy Policy&Planning Office (EPPO), Ministry of Energy.
Value(s) applied	Refer to Appendix 4 of register PDD
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0

Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$FC_{i,m,y}$**
Unit	Mass or volume unit
Description	Amount of fossil fuel type i consumed by the power plant/unit m in year y
Source of data	Electricity Generating Authority of Thailand (EGAT)
Value(s) applied	Refer to Appendix 4 of register PDD
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	**$EG_{m,y}$**
Unit	MWh
Description	Net quantity of electricity delivered to the grid by power plant / unit m serving the system, not including low-cost / must run units, in year y
Source of data	Electricity Generating Authority of Thailand (EGAT)
Value(s) applied	Refer to Appendix 4 of register PDD
Choice of data or measurement methods and procedures	Data choice and calculation method as per the latest version of the methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0
Purpose of data/parameter	Calculation of baseline emissions

Data/parameter:	**$EF_{grid,y}$**
Unit	t CO_2/MWh
Description	CO_2 emission factor of the grid
Source of data	Calculated
Value(s) applied)	0.4786
Choice of data or measurement methods and procedures	The Grid Emission Factor of Thai National Grid is calculated using the latest version 04.0 of "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions
Additional comments	This value is used for the entire crediting period.

Data/Parameter	**$EF_{grid,OM,y}$**
Unit	t CO_2/MWh
Description	Simple Operating Margin
Source of data	Calculated
Value(s) applied	0.5383
Choice of data or measurement methods and procedures	The Grid Emission Factor of Thai National Grid is calculated using the latest
Purpose of data/parameter	version 04.0 of "Tool to calculate the emission factor for an electricity system"
Additional comments	This value is used for the entire crediting period.

Data/Parameter	$EF_{grid,BM,y}$
Unit	t CO_2/MWh
Description	Build Margin
Source of data	Calculated
Value(s) applied	0.2996
Choice of data or measurement methods and procedures	The Grid Emission Factor of Thai National Grid is calculated using the latest version 04.0 of "Tool to calculate the emission factor for an electricity system"
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This value is used for the entire crediting period.

D.2. Data and parameters monitored

Data/parameter:	$EG_{PJ,facility,y}$
Unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Measured/calculated/default	Calculated
Source of data	Electricity meters (from $EG_{PJ,export}$ and $EG_{PJ,import}$)
Value(s) of monitored parameter	3,736
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Continuous monitoring, hourly measurement and at least monthly recording.
Calculation method (if applicable):	Calculated the difference between (a) the quantity of electricity supplied by the project plant/unit to the grid (**$EG_{PJ,export}$**); and (b) the quantity of electricity the project plant/unit from the grid (**$EG_{PJ,import}$**). The plant officer is responsible for this calculation.
QA/QC procedures:	Quantity of net electricity supplied to the grid crosschecked with records for sold or purchased electricity (e.g. invoices/receipts issued by PEA).
Purpose of data:	Calculation of baseline emissions
Additional comments:	The net electricity supplied to the grid is the difference between the measured quantities of the export electricity and the import electricity. $EG_{PJ,facility,y} = EG_{PJ,export,y} - EG_{PJ,import,y}$

Data/parameter:	$EG_{PJ,export,y}$
Unit	MWh
Description	The quantity of electricity supplied by the project plant/unit to the grid
Measured/calculated/default	Measured
Source of data	Electricity meter
Value(s) of monitored parameter	3,842

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Back up export meter
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<tr><td>Calculation method (if applicable):</td><td>Monitored continuously by the electricity meter. The amount of export electricity is recorded based on monthly basis by plant officer.</td></tr>
<tr><td>QA/QC procedures:</td><td>Meter was calibrated periodically as per national standard by accredited person or institution or EGAT. Data measured will be crosschecked by power delivery report issued by EGAT monthly.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
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Data/parameter:	**$EG_{PJ,import,y}$**
Unit	MWh
Description	The quantity of electricity delivered to the project plant/unit from the grid
Measured/calculated/default	Measured
Source of data	Electricity meter
Value(s) of monitored parameter	106

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<tr><td>QA/QC procedures:</td><td>Meter was calibrated periodically as per national standard by accredited person or institution or EGAT. Data measured will be crosschecked by electricity invoice from PEA monthly.</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments:</td><td>-</td></tr>
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D.3. Implementation of sampling plan

>> The data and parameter are not determined by sampling approach.

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>> According to the AMS-I.D, Version 18, the baseline emissions are calculated as follow;

$BE_y = EG_{pj,y} * EF_{grid,y}$
where

Parameter	Description	Value
BE_y	Baseline emission in year *y* (tCO_2)	1,788
$EG_{pj,y} = EG_{pj,facility,y}$	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh)	3,736
$EF_{grid,y}$	The Grid Emission Factor of Thai National Grid is calculated using the latest version 04.0 of "Tool to calculate the emission factor for an electricity system".	0.4786

Therefore the baseline emission during the monitoring period is 1,788 tCO_2e

E.2. Calculation of project emissions or actual net removals

>> Since the project activity and also there is no on-site fossil fuel consumption during project activity, the project emission due to this project is considered as zero.
$PE_y = 0\ tCO_2e$

E.3. Calculation of leakage emissions

>> As per AMS-I.D, Version18, para 42, General guidance on leakage in biomass project activities shall be followed to quantify leakages pertaining to the use of biomass residues. This project will not involve any use of biomass residues. Hence, the leakage emission associated with this project activity is considered as zero.
$LE_y = 0\ tCO_2e$

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	1,788	0	0	0	1,788	1,788

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
1,788	2,412

E.6. Remarks on increase in achieved emission reductions

>> The project was not fully operational at the beginning of the operation therefore the actual value of emission reductions was less than the estimated value in registered PDD.