



**Monitoring report form for CDM project activity
(Version 07.0)**

MONITORING REPORT

Title of the project activity	La Ferme – Bambous 15 MW solar power farm	
UNFCCC reference number of the project activity	10317	
Version number of the PDD applicable to this monitoring report	1.2	
Version number of this monitoring report	1.0	
Completion date of this monitoring report	29/08/2019	
Monitoring period number	4	
Duration of this monitoring period	01/01/2017 to 31/07/2019	
Monitoring report number for this monitoring period	MR4	
Project participants	SARAKO PVP Co. Ltd	
Host Party	Mauritius	
Applied methodologies and standardized baselines	ACM0002 version 16.0 ASB0019 version 01.0	
Sectoral scopes	Sectoral Scope 1: Energy Industries (renewable / non-renewable sources)	
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
	-	53,275
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	58,073	

SECTION A. Description of project activity

A.1. General description of project activity

La Ferme - Bambous Solar Photovoltaic Power Plant ("the project") is a greenfield 15.2 MW solar photovoltaic power plant in Eau Bonne, Bambous (Mauritius). The project activity undertaken by project promoter SARA KO PVP Co. Ltd ("SARA KO") therefore substitutes Mauritius grid's fossil-intensive electricity by clean and renewable energy, and cut down GHG emissions. Apart from emission reductions, the benefits of the project comprise, among others, improvement of energy self-sufficiency of the country, as well as creation of local employment.



Figure 1: La Ferme - Bambous Solar Photovoltaic Power Plant, aerial view

The project is the first large-scale solar PV power plants on the island. During this fourth monitoring period starting on 01/01/2017 and ending on 31/07/2019, the project generated 53,275 tCO₂e emission reductions.

The PV modules installed are of make TW250P660 from Tianwei New Energy Holdings Co., Ltd. (TWNE), an affiliate of China South Industries Group Corporation (CSGC). They are of high-efficiency, poly-crystalline silicon solar cells with high transmission and tempered glass, which results in module efficiency of up to 15.4%. According to the manufacturer's warranty, the average annual power output degradation of the module does not exceed 0.7% in the following 23 years, ending with 83% at the end of the 25th year¹. For the Balance of System components, including inverters, average lifetime is estimated at 10-15 years.²

In the solar photovoltaic power plant, 25 modules are connected to form a string having an output power of 6.25 kWp. There are 2,432 strings in the facility. Up to a maximum of 21 strings are collected together to form an array and there are 114 arrays in the facility. The solar facility consists of 17 Inverter Units, 6 units of 630 kVA, 2 units of 750 kVA and 9 units of 1,000 kVA, of make ABB AG. Moreover, 13 transformers of 400/22 kV are installed in the inverter substations. All 22 kV output from the inverter substations are connected through underground cables to the Seller's Substation whereby the power is stepped up to 66 kV through a power transformer. The auxiliary power is supplied from the 22 kV bar at the seller's substation. The stepped power at 66 kV is then exported to CEB's La Chaumiere's Substation through approximately 4.5 km of overhead transmission line.

The engineering, procurement and construction contractor for the project was Germany's Conecon GmbH. All installed technologies, systems and equipment are new. Additionally, PowerLogic® ION8600 meters are installed within Sarako solar farm premises for internal use and cross-check.

Relevant Implementation Dates

Event	Date
Start of the construction of the plant	01/08/2013
Commissioning Date	18/02/2014

A.2. Location of project activity

The project is located on a 337,668 m² plot of land forming part of the State Land Saint Pierre and the State Land La Ferme at Eau Bonne, Bambous, Mauritius.

The project geo-coordinates are: latitude 20°15'37.57 S, longitude 57°25'36.50" E.

¹ A warranty of 10 years is provided on workmanship and material.

² cf. Mason et al. 2006: Energy Pay-Back and Life Cycle CO₂ Emissions of the BOS in an Optimized 3.5 MW PV Installation in: Progress in Photovoltaics Research and Applications, 14:179-190.

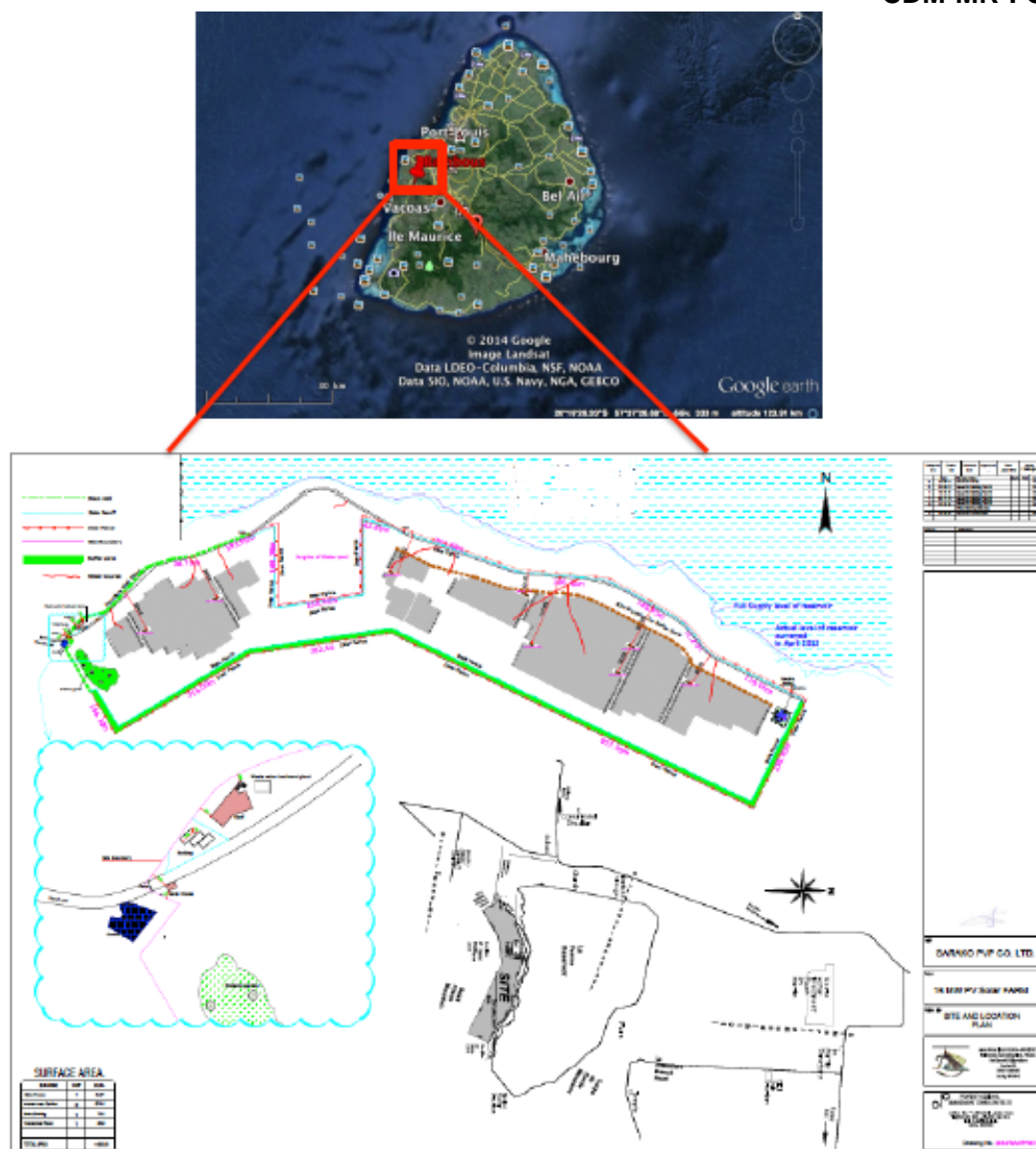


Figure 2: Project location and layout

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Mauritius (host)	SARAKO PVP Co. Ltd.	No

A.4. References to applied methodologies and standardized baselines

The approved baseline and monitoring methodology applied in the proposed project activity is ACM0002 (Version 16.0) – Large-Scale Consolidated Methodology for “grid-connected electricity generation from renewable sources”.

In line with the application of ACM0002 methodology, the project refers to the following tools:

- Tool to calculate the emission factor for an electricity system (Version 5.0)
- “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”

The standardized baseline ASB0019 (Version 01.0) - Standardized baseline: Grid emission factor of Mauritius is also applied by the project activity.

A.5. Crediting period type and duration

The project crediting period started on 05/08/2016. It lasts 10 years (i.e. 120 months) and is not renewable

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The PV modules installed are of make TW250P660 from Tianwei New Energy Holdings Co., Ltd. (TWNE), an affiliate of China South Industries Group Corporation (CSGC). They are of high-efficiency, poly-crystalline silicon solar cells with high transmission and tempered glass, which results in module efficiency of up to 15.4%. According to the manufacturer's warranty, the average annual power output degradation of the module does not exceed 0.7% in the following 23 years, ending with 83% at the end of the 25th year³. For the Balance of System components, including inverters, average lifetime is estimated at 10-15 years.⁴

In the solar photovoltaic power plant, 25 modules are connected to form a string having an output power of 6.25 kWp. There are 2,432 strings in the facility. Up to a maximum of 21 strings are collected together to form an array and there are 114 arrays in the facility.

Table 1: Characteristics of Solar PV Modules⁵

Electrical Characteristics		Mechanical specifications	
Maximum Power (Pmax)	250 W	Dimensions	1,640×992×40 mm
Maximum Power Voltage (Vmp)	30.5	Weight	19.5 kg
Maximum Power Current (Imp)	8.2	Max. static load, front (snow & wind)	5,400 Pa
Open Circuit Voltage (Voc)	37.8	Max. static load, back (wind)	2,400 Pa
Short Circuit Current (Isc)	8.85	Max. hailstone impact (diameter/velocity)	25 mm / 23 m/s
Encapsulated Cell Efficiency (%)	17.3		
Module Efficiency (%)	15.4		
Power Tolerance (W)	0~5		
Maximum Series Fuse Rating (A)	15		
Maximum System Voltage (TUV)	DC 1000 V		
Normal Operating Cell Temperature (°C)	45±3		

The solar facility consists of 17 Inverter Units, 6 units of 630 kVA, 2 units of 750 kVA and 9 units of 1,000 kVA, of make ABB AG. Moreover, 13 transformers of 400/22 kV are installed in the inverter

³ A warranty of 10 years is provided on workmanship and material.

⁴ cf. Mason et al. 2006: Energy Pay-Back and Life Cycle CO₂ Emissions of the BOS in an Optimized 3.5 MW PV Installation in: Progress in Photovoltaics Research and Applications, 14:179-190.

⁵ <http://www.dreamenergies.com/wp-content/uploads/2014/07/TWxxxP6601.pdf>

substations. All 22 kV output from the inverter substations are connected through underground cables to the Seller's Substation whereby the power is stepped up to 66 kV through a power transformer. The auxiliary power is supplied from the 22 kV bar at the seller's substation. The stepped power at 66 kV is then exported to CEB's La Chaumiere's Substation through approximately 4.5 km of overhead transmission line.

The engineering, procurement and construction contractor for the project was Germany's Conecon GmbH. All installed technologies, systems and equipment are new. Additionally, PowerLogic® ION8600 meters are installed within Sarako solar farm premises for internal use and cross-check.

Table 2: Relevant implementation dates

Milestones	Date
Measurements and planning	Mar-Apr. 2013
Local stakeholders consultations	Apr-Jun. 2013
Site preparation (civil works)	August 2013
EIA license	19/08/2013
Building and Land Use Permit	15/11/2013
Drilling and mounting of the panels	Nov-Dec. 2013
Commissioning Date	18/02/2014
1st monitoring period (VCS)	18/02/2014 to 31/08/2015
2nd monitoring period (VCS)	01/09/2015 to 04/08/2016
3rd monitoring period (CDM)	05/08/2016 to 31/12/2016
4th monitoring period (VCS)	01/01/2017 to 31/07/2019

B.2. Post-registration changes

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

N/A

B.2.2. Corrections

N/A

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

N/A

B.2.4. Inclusion of monitoring plan

N/A

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

N/A

B.2.6. Changes to project design

N/A

B.2.7. Changes specific to afforestation or reforestation project activity

N/A

SECTION C. Description of monitoring system

The project monitoring complies with the monitoring methodology ACM0002 Version 16.0 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources", whereby it is stated that:

"All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables [in B.7.1.]. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards".

Therefore, the quantity of net electricity generation supplied by the project plant to the grid has been reliably monitored through calibrated electricity meters and cross-checked with monthly sales invoices to the power purchaser, the Central Electricity Board.

Organization Structure

The Country Manager of SARA KO PVP Co. Ltd coordinates and endorses the overall responsibility for all CDM monitoring of the project, including:

- Develop, approve, execute, and improve the CDM Monitoring/Reporting Procedures;
- Organize in-house seminar to inform and train the company staff to the monitoring procedures;
- Ensure that instrumentations and devices are available and properly suited to efficiently perform the monitoring;
- Communicate and coordinate the monitoring work of all business units;
- Validate and electronically archive all monitoring data on a monthly basis throughout the crediting period (and conserve it at least for 2 further years);
- Calculate and report the emission reductions; and
- Coordinate the DOE work during the verification audit.

The Country Manager might appoint a CDM coordinator to delegate him the above specific tasks of monitoring supervision.

The Technical/Engineering/Maintenance Department consisting of plant technicians will undertake the technical actions required by the monitoring plan, under the Country Manager's authority, to collect and record related data.

The Accounting/Sales Department (Chief Financial Officer) will crosscheck, reconcile or consolidate data with multiple sources whenever possible. At minimum, data obtained from the electricity meters is to be crosschecked with the electricity sales receipts. This kind of reconciliation activity will be recorded properly as DOE may request for such information during the verification.

Monitoring procedures

The Meter Laboratory (ML) of CEB is solely responsible for the selection, installation, calibration, servicing, testing and repairing of all energy meters. The ML has recently acquired a sophisticated test bench to enable testing of electronic meters which have been put in service for registering the electricity consumption of maximum demand customers. Moreover, the SARA KO PVP Co. Ltd's back up meters shall be sealed by CEB in the presence of both parties and break only by CEB when required.

Data collection, consolidation and results analysis is undertaken by a dedicated team adequately trained, well aware of CDM requirements.

Internal auditing performance

The quantity of net electricity generation supplied by the project plant/unit to the grid every year is measured continuously and recorded at least once a month. The equipment used to ensure the measurement is a three-phase electronic electricity meters at CEB substation.

SECTION D. Data and parameters**D.1. Data and parameters fixed ex ante**

Data/Parameter	EF _{grid,CM,y}
Unit	tCO ₂ /MWh
Description	Combined margin CO ₂ emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”
Source of data	As per ASB0019 Version 01.0
Value(s) applied	0.966
Choice of data or measurement methods and procedures	As per ASB0019 Version 01.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	EF _{grid,OM,y}
Unit	tCO ₂ /MWh
Description	Operating Margin CO ₂ emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”
Source of data	As per ASB0019 Version 01.0
Value(s) applied	1.017
Choice of data or measurement methods and procedures	As per ASB0019 Version 01.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	EF _{grid,BM,y}
Unit	tCO ₂ /MWh
Description	Build Margin CO ₂ emission factor for grid connected power generation in year y calculated using the latest version of the “Tool to calculate the emission factor for an electricity system”
Source of data	As per ASB0019 Version 01.0
Value(s) applied	0.813
Choice of data or measurement methods and procedures	As per ASB0019 Version 01.0
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	The percentage share of total installed capacity of solar PV
Unit	%
Description	The percentage share of total installed capacity of the solar PV in the total installed grid connected power generation capacity in the host country.
Source of data	Statistics Mauritius (2014): Digest of Water and Energy Statistics - 2013, Port Louis.
Value(s) applied	0.3
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Additionality demonstration
Additional comments	-

Data/Parameter	The total installed capacity of solar PV
Unit	MW
Description	The total installed capacity of the solar PV in the host country.
Source of data	Statistics Mauritius (2014): Digest of Water and Energy Statistics - 2013, Port Louis.
Value(s) applied	2.46
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Additionality demonstration
Additional comments	-

D.2. Data and parameters monitored

Data/Parameter	EG _{facility,y}				
Unit	MWh/yr				
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y				
Measured/calculated/default	Measured				
Source of data	Electricity meter(s) at CEB sub-station.				
Value(s) of monitored parameter	y	2017	2018	2019	
	Exports	22 094,8	21 614,4	12 021,3	
	Imports	219,5	221,2	123,8	
	EG _{facility,y}	21 875,4	21 393,2	11 897,4	
Monitoring equipment	Three-phase electronic electricity meters at CEB substation. The CEB Meters measure the net electrical energy delivered to CEB by SARA KO PVP Co. Ltd with the following specifications: <ul style="list-style-type: none">Make: EDM I Model: MK6E V= 3x57-259VI: 1(6)A (50/60Hz)Accuracy class: 0.2S (±0.02%) LED Impulse: 0.1 imp/kWh				

	Country of origin: Singapore <ul style="list-style-type: none"> ▪ SN: # 14502802 (main) & # 14502803 (back-up) ▪ CT ratio: 200/1 PT ratio: 66kV/110V ▪ Last calibration date: 26/01/2018, valid until 25/01/2022 ▪ Previous calibration date: 07/02/2014, valid until 06/02/2018
Measuring/reading/recording frequency	Continuous measurement and at least monthly recording
Calculation method (if applicable)	n/a
QA/QC procedures	Cross check of measurement results with records for sold electricity. Meter Laboratory (ML) of CEB is solely responsible for the selection, installation, calibration, servicing, testing and repairing of all energy meters. <i>As per PPA §12.1.4, CEB shall inspect each CEB Meter upon installation and at least once every year thereafter. CEB shall check the certification of CEB Meters through an accuracy test at least once every 4 (four) years thereafter or at any time the readings of Net Energy from the CEB Meter and Seller Back-up Meter differ by an amount greater than 0.5%.</i>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

D.3. Implementation of sampling plan

N/A

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

Baseline emissions include only CO₂ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$$

Where:

BE_y = Baseline emissions in year y (tCO₂/yr)

$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

$EF_{grid,CM,y}$ = Combined margin CO₂ emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO₂/MWh)

In this fourth monitoring period (01/01/2017 to 31/07/2019), the GHG baseline emissions were **53,275 tCO₂e** such as detailed in table below.

	EG_y (MWh)	EF_y (tCO₂e/MWh)	BE_y (tCO₂e)
2017	21 875,4	0.966	21 126
2018	21 393,2	0.966	20 660

2019	11 897,4	0.966	11 489
TOTAL	55 166		53 275

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

The only fossil CO₂ emissions from the project activity come from the 10 kVA diesel emergency unit installed at the plant. This unit is relied on only for backup power of the servers and security lighting. Yet according to ACM0002 §37, for all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected, therefore, PE_y = 0.

E.3. Calculation of leakage emissions

As newly built solar power plant, there is no energy generating equipment transferred from another activity and no existing equipment transferred to another activity. The emissions potentially arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, transport etc.) are neglected. Therefore according to methodology ACM0002 there is no need to consider leakage for the proposed project, thus L_y = 0.

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

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	53,275	-	-	-	53,275	53,275

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 ₂ e)	Amount estimated ex ante for this monitoring period in the PDD (t CO ₂ e)
53,275	58,073

E.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the PDD”

Estimated ex-ante emission reduction as per registered PDD for the current monitoring were:

- 22 632 tCO₂ for 01/01/2017-31/12/2017
- 22 450 tCO₂ for 01/01/2018-31/12/2018
- 22 271 tCO₂ for 01/01/2019-31/12/2019, i.e. 7/12*22,271 = 12,991 for 01/01/2019-31/07/2019

thus a total estimated ex-ante emission reduction volume of 58,073 tCO₂ for 01/01/2017-31/07/2019; actual ex-post emission reductions happen to be 8% lower due to maintenance off-time and slight under-radiations for the same period.

E.6. Remarks on increase in achieved emission reductions

N/A

E.7. Remarks on scale of small-scale project activity

N/A

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

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