Monitoring report form

(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT		
Title of the project activity	Small-Scale Hydropower Project Sahanivotry in Madagascar	
UNFCCC reference number of the project activity	3558	
Version number of the monitoring report	1	
Completion date of the monitoring report	23/06/2016	
Monitoring period number and duration of this monitoring period	3rd monitoring period (01/06/2015 – 31/05/2016)	
Project participant(s)	HYDELEC Madagascar SA	
Host Party	Madagascar	
Sectoral scope(s)	Sectoral scope 01: Energy industries (renewable - / non-renewable sources)	
Selected methodology(ies)	ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (version 13.0.0)	
Selected standardized baseline(s)	-	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	44,196	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	-	38,980

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The purpose of the Sahanivotry Hydro Power Plant (hereafter referred to as "SHPP") is to generate renewable energy using clean hydropower and sell the output electricity into the regional grid of Antananarivo (hereafter referred to as RI TANA) operated by JIRAMA.

SHPP is a run-of-river hydropower plant with a capacity of 16.5 MW with an average electricity generation of 80 GWh (up to 90 GWh in optimal years). The project uses three new Pelton turbines and three new generators provided by Hunan Lingling Hengyuan Generating Equipment Co., Ltd (China).

The project construction was commenced in March 2007, and the hydropower plant started commercial operation in October 2008.

The project has been implemented according to the following time schedule:

Table 1 – Time schedule of project implementation

Nr	Milestones	Key Dates
1	**Authorization**	**02/2001-11/2007**
1.1	Concession for the installation and operation of SHPP with an installed capacity of 10 MW Issuing Authority: Ministry of Energy and Mines (MEM)	17/02/2001
1.2	Approbation of the concession contract for the production of energy at HPP with an installed capacity of 10 MW Issuing Authority: MEM	23/03/2001
1.3	Authorisation for starting construction and increasing capacity from 10 to 15 MW Issuing Authority: MEM	07/03/2007
1.4	Authorization for the increase of capacity by 5 MW at SHPP. Issuing authority: MEM	28/11/2007
2	**Power Purchase Agreement with Jirama**	**02/2001-08/2007**
2.1	Signature of Power Purchase Agreement (PPA)	17/02/2001
2.2	PPA amendment Nr. 1	27/06/2001
2.3	PPA amendment Nr. 2	12/10/2006
2.4	PPA amendment Nr. 3	16/08/2007
3	**Financing**	**07-09/2007**
3.1	Loan Agreement with African Development Bank (AfDB)	05/07/2007
3.2	Loan Agreement with BFV-Société Générale and Mauritius Commercial Bank (Madagascar) S.A.	06/09/2007
4	Construction	03/2007-09/2008
4.1	Start of construction	03/2007
4.2	Procurement and installation of HPP	05-09/2008
5	**Start operation**	**01/10/2008**

Due to the fact that SHPP was registered under CDM only on 28/08/2010, the CDM crediting period starts with the CDM registration date. As a result of exporting renewable energy to the fossil fuel intensive national grid, the accrued emission reductions from June 1st, 2015 until May 31st, 2016, amounted to 38,980 tCO_2.

A.2. Location of project activity

The project is located about 30 km from Antsirabé on the river Ampamehana within Sahanivotry village, Antananarivo Province, Madagascar. The Ministry of Energy granted to HYDELEC for a period of 30 years the right to use 70 ha of land that belongs to Sahanivotry village for the construction and operation of the SHPP. The geographical co-ordinates of the project are 47°08' East (longitude) and 20°12' South (latitude).

Figure 1 – The project location

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Madagascar (host)	HYDELEC Madagascar SA (Private Entity)	No

A.4. Reference of applied methodology and standardized baseline

The baseline and monitoring methodology ACM0002 “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” (version 13.0.0 EB 67) is applied to the project activity.

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

- “Tool to calculate the emission factor for an electricity system” (version 03.0.0 EB 70),
- “Tool for the demonstration and assessment of additionality” (version 07.0.0 EB 70),
- “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (version 02 EB 41).

A.5. Crediting period of project activity

The fixed CDM crediting period is from 28/08/2010 (date of CDM registration) to 27/08/2020.

A.6. Contact information of responsible persons/entities

The person(s)/entity(ies) responsible for completing the CDM-MR-FORM is Alexandre Dunod, ecosur afrique, Regional manager, a.dunod@ecosurafrique.com, +230 404 6060.

Ecosur afrique is not a project participant.

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

The project construction was commenced in March 2007, and the hydropower plant started commercial operation in October 2008 based on the following technical specifications, as per registered PDD.

Table 2 – Installed equipment characteristics

Turbines	Manufacturer	Model	Type	Rated Power	Rated head	Rated flow
3	Hunan Lingling Hengyuan Generating Equipment Co., Ltd (China)	CJA237-W-140/2x18	Pelton	5,676 kW	210 m	3.12m^3/s
Generator	**Manufacturer**	**Model**	**Type**	**Rated Power**	**Rated voltage**	**Rated rotation speed**
3	Hunan Lingling hegyuan Generating Equipment Co., Ltd (China)	SFW5500-14/2420	-	5.5 MW	6.3 kV	428.6 r/min

During this monitoring period, the project has operated continuously and satisfactorily, with the exception of the following event:

- From 27 to 30th of July 2015, some technical problems on the cooling system of generators and bearings required to stop the power plant temporarily.
- From October 5th to December 4th 2015, the power plant was completely stopped for the following refurbishment activities to be performed:
  - new sedimental trap connection between pool n°1 and pool n°2 in the water intake
  - enlargement of pool n°2
  - new cooling system of generators and bearings
  - new automation system
  - new Pelton runners
- On 13th, 14th and 23th of December 2015, some complementary works were performed on the new cooling system

No other relevant events or situations have been reported during the monitoring period. Regular maintenance is undertaken unit after unit in order to minimize impacts on overall continuous production, according to maintenance schedule. Routine sand removal operations take place up to twice or thrice a month during rainy season, for short durations of 8 to 10 hours only, usually conducted in parallel of JIRAMA grid maintenance. Corresponding back-up diesel generator use times are reported in section E.2, amounting to a total of 152 hours during the monitoring period.

No legislation change occurred in Madagascar since the Concession Agreement with Ministry of Energy and the Power Purchase Agreement with JIRAMA were signed.

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

N/A

B.2.2. Corrections

N/A

B.2.3. Changes to start date of crediting period

N/A

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

N/A

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

A post-registration changes was undertaken during 1st monitoring period (reference PRC-3558-001 approved on Nov 12, 2013); no other changes occurred subsequently.

B.2.6. Changes to project design of registered project activity

A post-registration changes was undertaken during 1st monitoring period (reference PRC-3558-001 approved on Nov 12, 2013); no other changes occurred subsequently.

B.2.7. Types of changes specific to afforestation or reforestation project activity

N/A

SECTION C. Description of monitoring system

The data to be monitored is the net electricity supplied to the regional grid and any diesel consumed by the emergency back-up diesel generator.

Energy meters

Two bi-directional energy meters M1 and M2 (ACTARIS SL 7000 Type SL 761 B 060 manufactured by ACTARIS France with a respective accuracy of 0.5% and 1%) have been installed for monitoring the generated power, according to the national practice set by JIRAMA.

The meters register the following information:

- Active power
- Reactive power
- Apparent power
- Voltage
- Phase's current
- Active energy
- Frequency

- Event record
- Harmonies

The electricity delivered from SHPP to the regional grid is thus continuously monitored through these metering equipments installed at project site, two bi-directional electricity meters M1 and M2:

Table 3 – Electricity meters characteristics

Meters label	Serial Number	Characteristics	Accuracy	Use
M1 ***(main)***	33055428	bi-directional	0,5 %	Monitoring of net electricity supplied by the project
M2 ***(back-up)***	36050447	bi-directional	1 %	Used in case of failure of M1

M1 (and M2 backup) readings are measured thanks to bi-directional meters, allowing to deduct SHPP's eventual power import from the grid for its auxiliary consumption when not operational (and alternatively to its emergency diesel generator). Billing is then processed under a monthly invoice from Hydelec to JIRAMA based on measurements of electricity exported, double-checked by JIRAMA headquarters and Antsirabe sub-station before payment.

Table below provides indicative information along monitoring period regarding activities/observation/measures taken for monitoring energy generated by the project mentioning with which meter information has been collected.

Table 4 – Monitoring events

Period	***Activities***	***Observations/Measures taken***
01.06.2015 to 31.05.2016	M1 and M2 in function	Data collection from M1

The following grid connection diagram indicates the principles of positioning of metering instruments that have been used in the monitoring of the emission reductions. Staff record the operation status and reading of metering equipments daily on site (6:00 am), which log-sheet of production recorded daily is provided to DOE. Furthermore, designated staff collect the measured electricity weekly before it is checked by the company administrator or supervisor regularly.

Two additional meters M3 (n°36050437 at Antsirabe sub-station) and M4 (n°73305393 at Holcim Ibity cement factory) are used by JIRAMA as a cross-check at Antsirabe's substation and Ibity end-user connection.

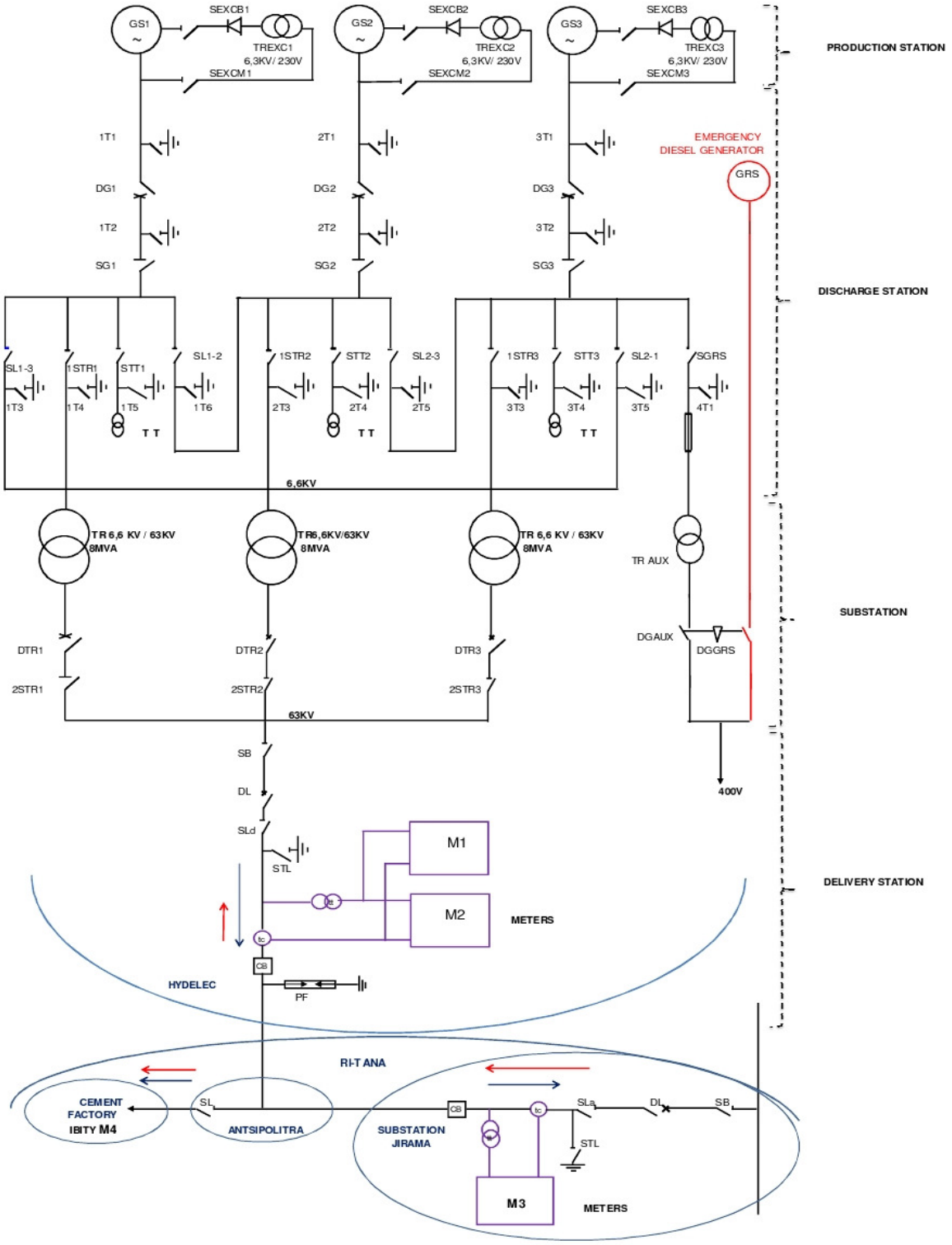


Figure 2 – Grid connection and meters diagram

SEXCB :low voltage excitation disconnector
SEXCM :Medium voltage excitation disconnector
TREXC :excitation transformer
DG :generator's circuit breaker
SG :generator's disconnector
CB :tank circuit
STR: transformer's disconnector
DTR: transformer's circuit breaker
STT: voltage transformer's disconnector
SL: link disconnector
ST: earthing switch
TRAUX : auxiliary transformer
DGAUX:auxiliary circuit breaker
DGGRS: emergency generator circuit breaker
TT:voltage transformer

SB: bus bar disconnector
DL: line's circuit breaker
GS: generator
SGRS: emergency diesel generator's disconnector
STL: line's earthing switch
Sla: line's disconnector
SLd: line's disconnector
M1,M2,M3, M4: kilowatt-hour meters
tc: current transformer
tt: voltage transformer
PF: surge arrester

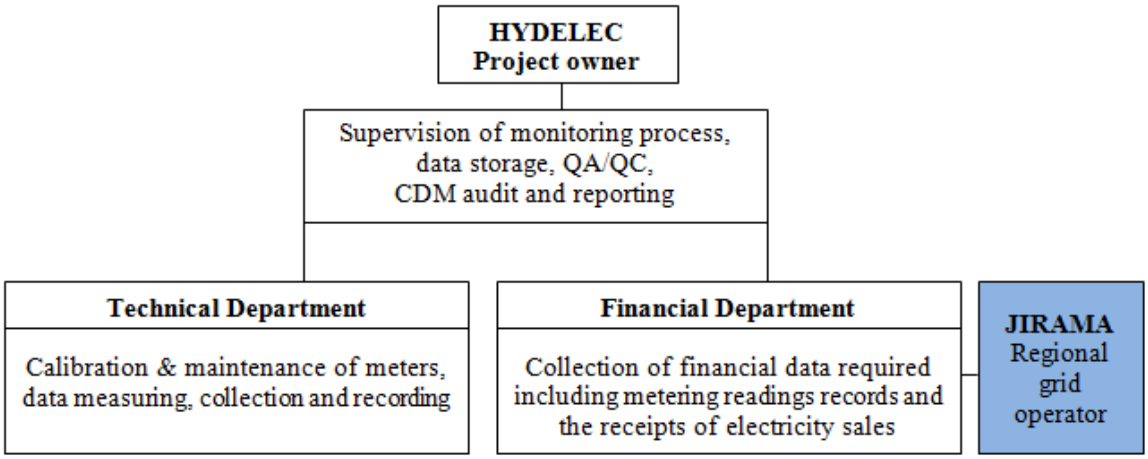
current direction when the plant is operational
current direction when the plant is shutdown

During any emergency or maintenance situation, and if back-up electricity is not available from the grid, the quantity of diesel fuel consumed by the diesel generator is measured and recorded in a log book.

The project owner HYDELEC took the responsibility of the monitoring plan implementation; HYDELEC appointed a CDM manager, who is responsible for the supervision of the monitoring process, the data measuring, collection and recording, QA/QC, audit and reporting.

The staff from technical and financial departments undertook the monitoring tasks including control of metering equipments periodically, collecting electricity data and completing records, checking and analyzing the data, archiving relevant records, reporting to the CDM manager.

Figure 3 – Monitoring and management structure



Quality assurance and quality control

The electricity delivered by SHPP to RI TANA is monitored trough metering equipment at the project site and invoiced monthly to JIRAMA. The data is cross-checked for quality control against electricity transmission records from JIRAMA dispatching department twice (at Antsirabe and at RI-Tana headquarter) before approval of the billing.

Calibration of meters occurs annually according to the national practice set by JIRAMA.
All relevant data records obtained from the monitoring are kept by the project owner during the crediting period and for at least two years after the end of crediting period.

Operational procedures, including emergency response and troubleshooting measures, are described in the implemented manuals (provided to the DOE) based on which the project staff is trained:

- Exploitation procedures manual (*Manuel de Procédures d'Exploitation*)
- CDM monitoring manual
- Quality management manual

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data/parameter:	**$FC_{i,m,y}$**
Unit	g/kWh
Description	Amount of fossil fuel type i consumed by power plant / unit *m* in year *y* within RI TANA
Source of data	JIRAMA (2007) Ministry of Energy and Mines, Least Cost Generation Master plan (2005)
Value(s) applied)	See Annex 3 of registered PDD
Choice of data or measurement methods and procedures	The data is from the national utility JIRAMA resp. Ministry of Energy and Mines.
Purpose of data	Calculation of baseline emissions
Additional comments	The uncertainty of the data is low.

Data/parameter:	**$EG_{m,y}$** and **$EG_{k,y}$**
Unit	MWh
Description	Net electricity generated and delivered to the RI TANA by power plant / unit *m* resp. *k* in year *y*
Source of data	JIRAMA (2004, 2005, 2006)
Value(s) applied)	See Annex 3 of registered PDD
Choice of data or measurement methods and procedures	The data is from the national utility JIRAMA resp. Ministry of Energy and Mines.
Purpose of data	Calculation of baseline emissions
Additional comments	The uncertainty of the data is low.

Data/parameter:	**$NCV_{i,y}$**
Unit	GJ/ton
Description	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	Fuel oil: 44.44 Diesel: 40.19
Choice of data or measurement methods and procedures	2006 IPCC Guidelines for National Greenhouse Gas Inventories are considered to be authoritative.
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**$EF_{CO2,i,j,y}$**
Unit	tCO_2/GJ
Description	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Workbook Vol.2.
Value(s) applied)	Fuel oil: 77.37 Diesel: 74.06

Choice of data or measurement methods and procedures	IPCC Guidelines for National Greenhouse Gas Inventories are considered to be authoritative.
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	λ_y
Unit	%
Description	Fraction of time when the low-cost must-run resources are on the margin in year *y*
Source of data	JIRAMA (2007)
Value(s) applied)	74
Choice of data or measurement methods and procedures	The data is from the national utility JIRAMA.
Purpose of data	Calculation of baseline emissions
Additional comments	The uncertainty of the data is low.

Data/parameter:	**EF_{CO2}** for the diesel consumed by the emergency back-up diesel generator
Unit	tCO2/kg of diesel
Description	CO_2 emission factor of diesel used for the emergency back-up diesel generator at SHPP
Source of data	Footnote of Table I.D.1 in AMS I.D. ver.13 mentions this conversion factor following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.
Value(s) applied)	3.2 tCO_2/kg of diesel
Choice of data or measurement methods and procedures	Default value
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**CAP_{BL}**
Unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data	Project site
Value(s) applied)	For new hydro power plants, this value is zero.
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity (no reservoir).

Data/parameter:	**ABL**
Unit	m^2
Description	Area of the reservoir measured in the surface of the water before the implementation of the project activity, when the reservoir is full
Source of data	Project site

Value(s) applied)	For new reservoirs, this value is zero
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity (no reservoir).

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 to the grid in year *y*
Measured/calculated/default	Measured
Source of data	Energy production records
Value(s) of monitored parameter	y: **2015**: 25,869; **2016**: 45,262; **Total**: 71,131 ($EG_{facility,y}$)
Monitoring equipment	Two bi-directional energy meters M1 (main) and M2 (back-up) are used to monitor the net electricity generated (ACTARIS SL 7000 Type SL 761 B 060; Serial number: 33055428 and 36050447; Manufactured by ACTARIS France with a respective accuracy of 0.5% and 1%). M1 and M2 are installed on the 63 kV substation of the hydro power plant to measure directly and continuously the electricity generation and the net electricity supply to the grid. The metering instruments M1 and M2 satisfy the accuracy class requirements as per Article 05 of original Power Purchase Agreement dated 17/02/2001 and have been calibrated on-site annually by JIRAMA in accordance with the national practice set by JIRAMA PPA and 16/08/2007 amendment about ownership and maintenance: **Table 5 - calibration events** **Calibration events** | **Validity** | **Delayed calibration?** | **Comment** 24/03/2015 | 23/03/2016 | Yes, from 24/03/2016 onwards | Calibration of both meters Both meters are always checked & calibrated together. During this third monitoring period, M1 & M2 were properly calibrated except for the period spanning from 24/03/2016 to 31/05/2016 when delayed calibration occurred (see calculation below).
Measuring/reading/recording frequency:	Measured continuously, recorded daily and aggregated monthly
Calculation method (if applicable):	The un-calibrated measurement period has been adjusted by deducting (respectively adding) the accuracy range of meters M1 and M2 from their export (respectively imports) readings: Delayed calibration period: 24/03/2016 to 31/05/2016 (M1) | Uncalibrated metered data (kWh): Exports: 21,209; Imports: 810; $EG_{facility,y}$: 20,399 | Applicable accuracy deduction: 0,5% | Adjusted data for ER calculation (kWh): Exports: 21,103; Imports: 811; $EG_{facility,y}$: 20,292

QA/QC procedures:	The electricity delivered by SHPP to RI TANA is monitored through metering equipment M1 (main) and M2 (back-up) at the project site, with a respective accuracy of 0.5% and 1%, and invoiced monthly to JIRAMA. The data is cross-checked for quality control against electricity transmission records from JIRAMA dispatching department twice (at Antsirabe and at RI-Tana headquarter) before approval of the billing. Billing is then processed under a monthly invoice from Hydelec to JIRAMA based on measurements of electricity supplied.
Purpose of data:	Calculation of baseline emissions
Additional comments:	In business-as-usual conditions, when both meters are operational, M1 is used for metering, and M2 in case of failure.

Data/parameter:	**FC_{diesel}**
Unit	kg
Description	The quantity of diesel fuel consumed by the diesel generator during any emergency situation
Measured/calculated/default	Calculated
Source of data	The emergency records and log book
Value(s) of monitored parameter	861,4
Monitoring equipment	-
Measuring/reading/recording frequency:	-
Calculation method (if applicable):	The total diesel consumption in volume, recorded from tank gauge readings, was converted into kilogram based on a highly conservative density value of 1 kg/L.
QA/QC procedures:	This is cross checked with the purchase receipts of diesel fuel and measurement conducted in the diesel storage tank.
Purpose of data:	Calculation of project emissions
Additional comments:	The diesel generator only operates in unplanned emergency situations. The hydropower plant has three turbines; therefore the maintenance is done during the dry season; where only one or two turbines are running. That means the maintenance of SHPP is done without any need of the diesel generator.

Data/parameter:	**$NCV_{diesel,y}$**
Unit	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description	Weighted average net calorific value of diesel fuel in year *y*
Measured/calculated/default	Default
Source of data	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG inventories, as neither local nor national values available.
Value(s) of monitored parameter	43.3
Monitoring equipment	-
Measuring/reading/recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions
Additional comments:	No revision of the IPCC Guidelines have been done thus not taken into account.

Data/parameter:	$EF_{CO2, diesel,y}$
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of diesel fuel in year *y*
Measured/calculated/default	Default
Source of data	IPCC default values at the upper 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, as neither local nor national values available.
Value(s) of monitored parameter	0.0748
Monitoring equipment	-
Measuring/reading/recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	Calculation of project emissions
Additional comments:	Applicable since Option B of the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion is used. Any future revision of the IPCC Guidelines should be taken into account however no revision have been done at the time of project verification.

Data/parameter:	CAP_{PJ}
Unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity
Measured/calculated/default	-
Source of data	Project site
Value(s) of monitored parameter	16,500,000
Monitoring equipment	-
Measuring/reading/recording frequency:	Monitored yearly
Calculation method (if applicable):	Determined based on recognized standards.
QA/QC procedures:	-
Purpose of data:	Applicability condition of methodology ACM0002
Additional comments:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity. As mentioned in Applicability conditions of the methodology ACM0002, the project is the installation of a new run-off-river hydro power plant and does not involve any reservoir.

Data/parameter:	A_{PJ}
Unit	m^2
Description	Surface area of the reservoir measured at full supply level after the implementation of the project activity.
Measured/calculated/default	-
Source of data	-
Value(s) of monitored parameter	-

Monitoring equipment	-
Measuring/reading/recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	Applicability condition of methodology ACM0002
Additional comments:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity. As mentioned in Table 4 (Applicability conditions of the methodology ACM0002), the project is the installation of a new run-off-river hydro power plant and does not involve any reservoir.

D.3. Implementation of sampling plan

No sampling plan is used thus section is not applicable.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

Baseline emissions include only CO_2 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 (tCO_2/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 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*" (tCO_2/MWh)

In this second monitoring period (01/06/2015 to 31/05/2016), the GHG baseline emissions was **38,980 tCO_2e** such as demonstrated in table below.

	EG_y (kWh)	EF_y (tCO_2e/MWh)	BE_y (tCO_2e)
jun-15	7 092 069	0,548	3 886
jul-15	5 187 732	0,548	2 843
aug-15	4 629 665	0,548	2 537
sep-15	2 965 421	0,548	1 625
oct-15	267 442	0,548	147
nov-15	- 15 544	0,548	-9
dec-15	5 742 290	0,548	3 147
jan-16	8 341 065	0,548	4 571
feb-16	7 984 913	0,548	4 376
mar-16	10 773 554	0,548	5 904
apr-16	10 022 364	0,548	5 492

may-16	8 140 562	0,548	4 461
Total	**71 131 534**		**38 980**

E.2. Calculation of project emissions or actual net GHG removals by sinks

The only fossil CO_2 emissions from the project activity come from the 60 kVA diesel emergency unit installed at the plant (downsized from former 100 kVA gen-set replaced). This unit is relied on only for unplanned emergency situations as the hydropower plant operates during 12 months per year. The hydropower plant has three turbines; therefore the maintenance is done during the dry season; where only one or two turbines were running. That means the maintenance is done easily without any need of the diesel generator.

The emergency system was only used to serve the plant when neither the power in the plant nor the grid power was available. Consequently, the back-up diesel generator operated for only 152 hours during the entire monitoring period, consuming 861 liters of diesel. Associated emissions have been conservatively calculated as less than 3 tCO_2 for the entire monitoring period, and confirmed as smaller than 1% of the total Emission Reductions by the DOE thus neglected:

$$PE_y = FC_{diesel,y} \times NCV_{diesel,y} \times EF_{CO2,\ diesel,y}$$

Where
$FC_{diesel,y}$ = diesel consumed by the emergency back-up diesel generator in year y;
$NCV_{diesel,y}$ = weighted average net calorific value of diesel fuel in year y;
$EF_{CO2,\ diesel,y}$ = weighted average CO_2 emission factor of diesel fuel in year ;

Period	$FC_{diesel,y}$ (kg)	EF_{CO2} (tCO_2e/kg)	PEy (tCO_2e)	Reason for diesel generator usage
	D	E	F=D*E	
2 015	661,40	0,0032	2,12	
2 016	200	0,0032	0,64	
Total	**861,4**		**2,76**	**< 1% of total Emission Reductions thus neglected**

E.3. Calculation of leakage

As newly built hydropower plant, there is no energy generating equipment transferred from another activity and no existing equipment transferred to another activity. Therefore according to methodology ACM0002 there is no need to consider leakage (L_y) for the proposed project, thus $L_y = 0$.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	38,980	-	-	-	38,980	38,980

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	44,196	38,980

E.6. Remarks on difference from estimated value in registered PDD

The actual emission reduction figures have been lower than projected in the PDD. This difference results from lower water levels than expected, as well as unavailability of the power plant during retrofitting works in November 2015.

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	HYDELEC
Street/P.O. Box	15, Avenue de l'Independance Analakely
Building	-
City	Antananarivo 101
State/region	-
Postcode	-
Country	Madagascar
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Contact person	Alessandro BERTI
Title	
Salutation	Mr.
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