Monitoring report form for CDM project activity
(Version 06.0)

MONITORING REPORT

Title of the project activity	Mwenga Hydro Power Project	
UNFCCC reference number of the project activity	9550	
Version number of the PDD applicable to this monitoring report	8.0	
Version number of this monitoring report	1	
Completion date of this monitoring report	23/03/2018	
Monitoring period number	Monitoring period: 3	
Duration of this monitoring period	01/02/2016 – 31/01/2018 (both days included)	
Monitoring report number for this monitoring report	1	
Project participants	Mwenga Hydro Limited Swedish Energy Agency	
Host Party	United Republic of Tanzania	
Sectoral scopes	Sectoral Scope 1: Energy industries (renewable - / non-renewable sources)	
Applied methodologies and standardized baselines	Renewable Electricity Generation for Captive use and Mini Grid (AMS-I.F. ver. 2) Grid connected renewable electricity generation (AMS-I.D. ver. 17)	
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
	0 tCO_2e	19,115 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	22,739 tCO_2e	

SECTION A. Description of project activity

A.1. General description of project activity

The Mwenga Hydro Power Project is a 3.486 MW run-of-river hydro power plant from the Mwenga river, located in Mufindi District of the Iringa Region in Southern Tanzania. The project is developed by Mwenga Hydro Ltd (MHL) and aims to generate electricity to meet the electricity requirements of the nearby Processing Factory and a number of local communities, as well as to export electricity to the Tanzanian power grid.

Approximately 2700 households located in the surrounding rural villages have been connected to an electricity grid for the first time and benefit from access to a modern and clean form of energy. These communities previously used diesel and kerosene for their domestic power and lighting needs. However, because the current baseline usage per household was so low, and essentially impossible to validate because of poor or non-existent recordkeeping, no emission reductions are claimed for this part of the project.

Electricity has also been sold on to the national grid through TANESCO, the national electricity utility, and has thus enabled the displacement of electricity which would otherwise be obtained from fossil fuel power plants connected to the grid. Electricity was supplied to nearby Processing Factories during the monitoring period, as the project completed the formal commissioning of the interconnection equipment needed to directly supply to nearby Processing Factories. Currently the project activity supplies electricity to Mufindi Tea & Coffee Limited and Unilever Tea Tanzania Limited.

The generation equipment is based on hydro electric technology, and consists of a single vertical axis Francis turbine that generates electricity at 6.6 kV, for subsequent transformation to match that required by the grid. The installed capacity of the project is 3.486MWe. The manufacturer of the Turbine is Serman Energy, it has a maximum nameplate capacity of 3612kW and serial number A100 45T. The manufacturer of the Alternator is Comelmar Italia, it is 5000kVa and has serial number 118957. Approximately 60 meters of head is available at this site through the use of a diversion weir, headrace, sediment tank, penstock, draft tube and tail race. The generated electricity is supplied to the interconnection facility that supplies both the grid, local villages and the MTC tea factory via a 33 kV overhead power line.

Construction of the project started on 17th November 2010 and was completed in August 2012. The project started commercial operation and received its interconnection certificate from the National Utility, TANESCO, on the 17th September 2012, after the successful start-up and commissioning of the plant on 1st September 2012. The hydro plant has operated successfully since this date, and continues to do so. CDM registration was achieved on 30th January 2013.

The total GHG emission reductions achieved over the current monitoring period that began at the beginning of the day on 01st February 2016 and completed at the end of the day of the 31st January 2018, is calculated as19,115 tCO_2e.

A.2. Location of project activity

Iringa Region in southern Tanzania, Mufindi District.

The hydro power plant site is located on the Mwenga River, at approximately 8°37'18.63" S 35°41'30.54" E for the weir and silt collection, and approximately 8°37'27.07" S 35°41'22.82" E for the powerhouse. The site is about 55km by dirt and gravel road from the MTC headquarters, which in turn is located some 30km by dirt and gravel road from the Mafinga Junction, which is the nearest paved road. Access to the site is available only by dirt and gravel roads in isolated mountainous terrain.

There is a small unpaved airstrip approximately 52 km by air from the site, but the site is still only accessible from there by dirt and gravel roads or by foot. The nearest public airport is the Iringa airport, which is approximately 170 km away by road. The nearest train station is at Makambako, about 100 km by air, and 160 km by road. The railway line—without a stop—passes within 20km of the site through the village of Mpanga, but the project site is accessible from there only by foot.

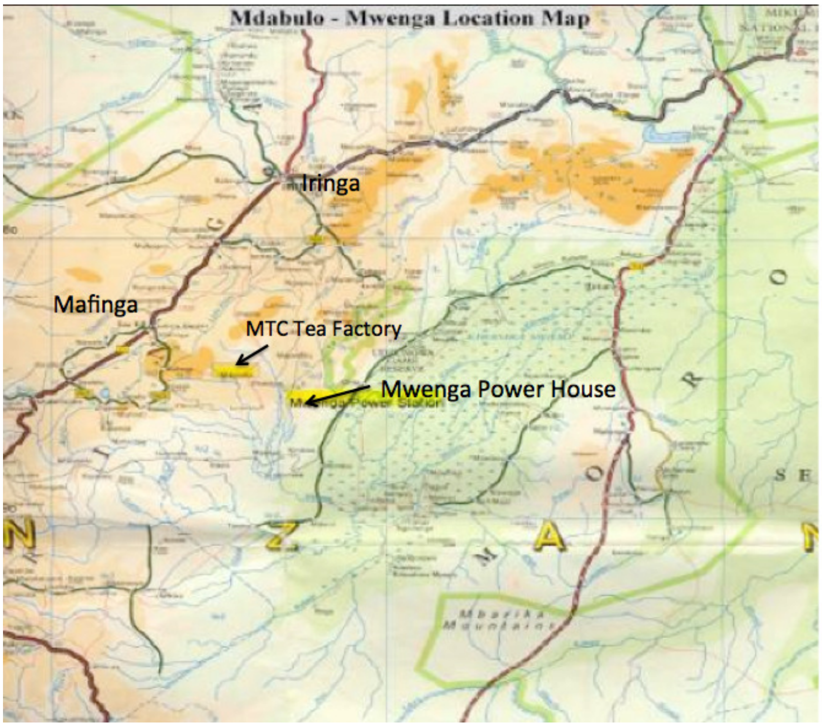

Fig A.1 – Location Map (Iringa Region) for Mwenga Hydro Plant

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
United Republic of Tanzania (Host)	Private entity: Mwenga Hydro Limited	No
Sweden	Public entity: Swedish Energy Agency	No

A.4. Reference to applied methodologies and standardized baselines

Renewable Electricity Generation for Captive use and Mini Grid (AMS-I.F. ver. 2), available at http://cdm.unfccc.int/methodologies/DB/9V3T8W0N5PMCJH4YVEA04YYFTVHP3Q.

Grid connected renewable electricity generation (AMS-I.D. ver. 17), available at http://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X

In addition, the following tool is used:
Tool to calculate the Emissions Factor for an electricity system (version 2.2.0), available at http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.0.pdf.

A.5. Crediting period type and duration

30/01/2013 – 29/01/2020 (Renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project is a 3.486 MW (at generator terminals) run-of-river hydro power plant operated by Mwenga Hydro Limited (MHL).

Hydrology: Considerable hydrological data have been recorded since 1957 by various entities, including the Tanzania Ministry of Water and MTC. According to the feasibility study conducted by Ninham Shand in July 2008, a flow rate of 7 m^3/s is exceeded 70% of the time (on an annual basis). [1]

Flow and the power potential: Based on a flow of 7m^3/s, using the design recommended in the feasibility study, estimated annual power generation of 24,000 MWh can be achieved[2], for a plant load factor of 82.8%, which was determined ex-ante, as substantiated in the registered Project Design Document (PDD).

The project is a run-of-river scheme diverting water via a diversion weir from the main river course to a small water channel / headrace running 70m to the forebay/desilting tank, where water then flows through a 340m long steel penstock pipe to the power house, and finally discharged back into the river via a draft tube and tail race. A single unit Francis turbine is installed in the powerhouse. The water drops a gross head of 60m from the forebay tank to the turbine.

The river between the extremities of the scheme includes a steep waterfall and a series of small rapids. The headrace canal effectively bypasses this normal watercourse and facilitates a controlled drop of approximately 60m through the penstock.

The location of the diversion weir is on a natural rock outcrop above the waterfall. A ledge in the rock, some 50m upstream of the falls, forms a natural weir with a solid foundation. This was ideal for the construction of a concrete weir. The valley sides at this position are relatively steep, facilitating a narrow and compact structure. A 2.5 m high concrete gravity weir structure is constructed on top of the natural rock to allow for adequate water draw-off facilities. A tongue wall extends into the hillsides at each end of the weir to provide for seepage cut off around the structure. The total crest length is approximately 25m. Draw off facilities take the form of a top entry grated channel feeding the headrace.

A 70m long (2 m x 2 m at a slope of 1V:750H) low-head closed conduit is constructed to convey water from the weir to the top of the penstock. It allows for soil, debris, and storm water flow to pass over the conduit and further provided the benefits of reduced excavation compared to an open canal. The conduit is graded to match the hydraulic losses at the design flow and takes a gently winding route around the hill to the headrace. The conduit is formed of in situ concrete.

The conduit is shallowly excavated. Where necessary, adequate cross drainage at regular intervals to prevent buoyancy, is provided. Drainage takes the form of a no-fines blinding layer and or wick drains on the up-slope side of the structure. Joints are sealed PVC water bar at 6m intervals. The closed conduit operates as a low-pressure conduit.

A sediment trap was constructed that slows the flow rate of the water down to 0.25 m/s (from 1.5 m/s) to allow settling to occur within the tank. The tank is equipped with flushing facilities to drain accumulated debris. A spillway was built into the side of the sediment tank in order to cater for

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[1] Mwenga River Hydro Project Feasibility Study Report Ninham Shand, July 2008.

[2] This corresponds to net generation output detailed in the financial model submitted to banks to justify financing.

varying powerhouse operation conditions which are likely to transmit surges through the penstock to the proposed canal. These surges will drain safely over the spillway back to the nearby river.

The 340m-long penstock is constructed from 1.5m diameter steel pipes, buried in places and provided with regular anchor blocks to ensure stability on the steep slope. This layout is suitable in view of the remoteness of the site for ease of construction.

For run-of-river type hydropower projects where stream flow passes through without much modification, specific flow release requirements are generally not required. However, this specific scheme diverts a portion[3] of the water from the Mwenga River which reduces flow over a stretch of some 0.45km of waterfalls and rapids. The length of river, which can potentially be deprived of flow during dry season is of the order of 450m and consists mainly of a high waterfall and some subsequent small rapids. After some testing and environmental monitoring, the final Water Use Permit was issued with a requirement of 1m^3/s environmental flow for maintenance of the river during periods of low flow.

A Francis type turbine is chosen for the project. This specific turbine is capable of operating at flow rates below 40% of the rated flow, and is unusually efficient in this regard. The turbine provides significant benefits in terms of space usage, efficiency, ease of installation and operation. Key technical characteristics of the technology applied in this project are given in the Table below:

Table B.1.: Technical characteristics[4]

Hydrology	
Design flow	7 m^3/sec
Design Head	60m
Turbine	
Type	Francis
Number of units	1
Power (turbine axis)@ 100% flow	3.612 MW[5]
Power (at generator Terminals)	3.486 MW[6]
Generator	
Type	Synchronous 3 Phase
Interlinked Voltage	6.6 KV
cosϕ	0.9
Frequency	50 Hz

The powerhouse has a floor plan of 140m^2, and is a conventional concrete and steel portal type structure, with brick infilling and metal sheet roofing, housing the turbine, generator, transformers and the operational control room.

[3] From the flow data of Mwenga River the flow of 7m^3/s will be insufficient only in three months i.e. October, November & December. The volume of water to be diverted to the power channel is 7 m^3 running every second. From the EIA conducted it is recommended that since there is no specific In-stream or Environmental Flow Requirements (EFR) defined for Tanzania, it was proposed that 10% of the observed annual minimum flow be left flowing to the normal river course which is 0.45m3/s as indicated in pg 130 of the Environmental Impact Statement, EIS report

[4] Serman Energy S.RL. Technical Specification for Hydroelectric Turbine and Generator Package .Mufindi, Iringa District, Tanzania.

[5] Maximum instantaneous power estimated at 3.850 MW after operational testing at very high water flow conditions.

[6] Maximum instantaneous power measured at 3.750 MW after operational testing at very high water flow conditions.

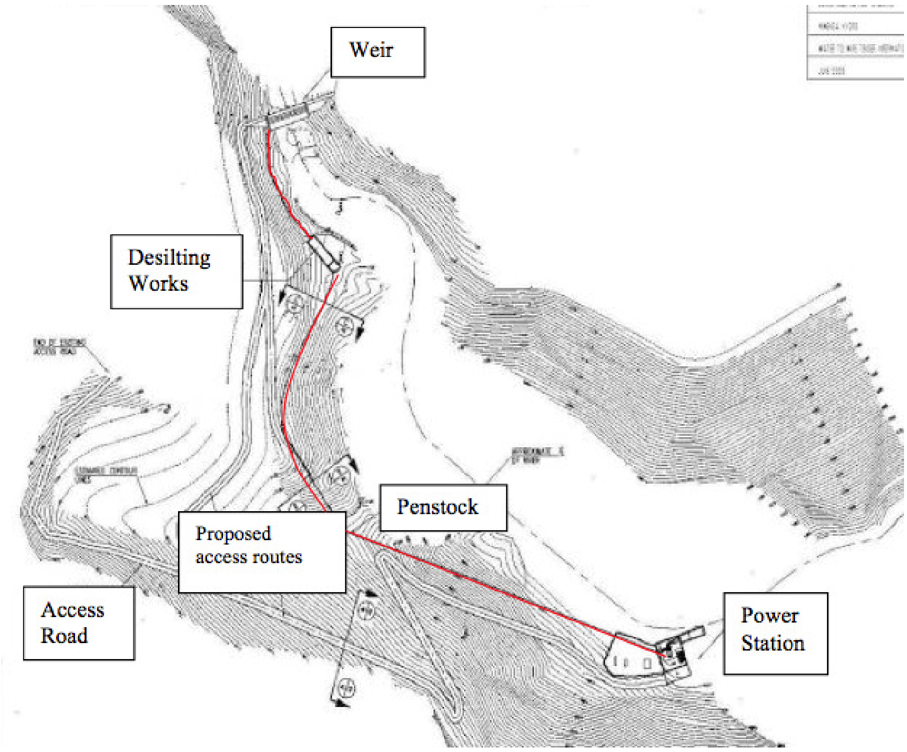


Figure B.1. Mwenga river falls and downstream view of the hydropower plant site[7]

Existing access roads to the power house site consist of dirt and gravel roads that presently provide access to the coffee plantations near the site and that are used for transportation of crops and equipment by 8 ton trucks. The final 10km is a smaller track, generally not provided with gravel wearing course, and has been improved in places to provide more permanent access to the site.

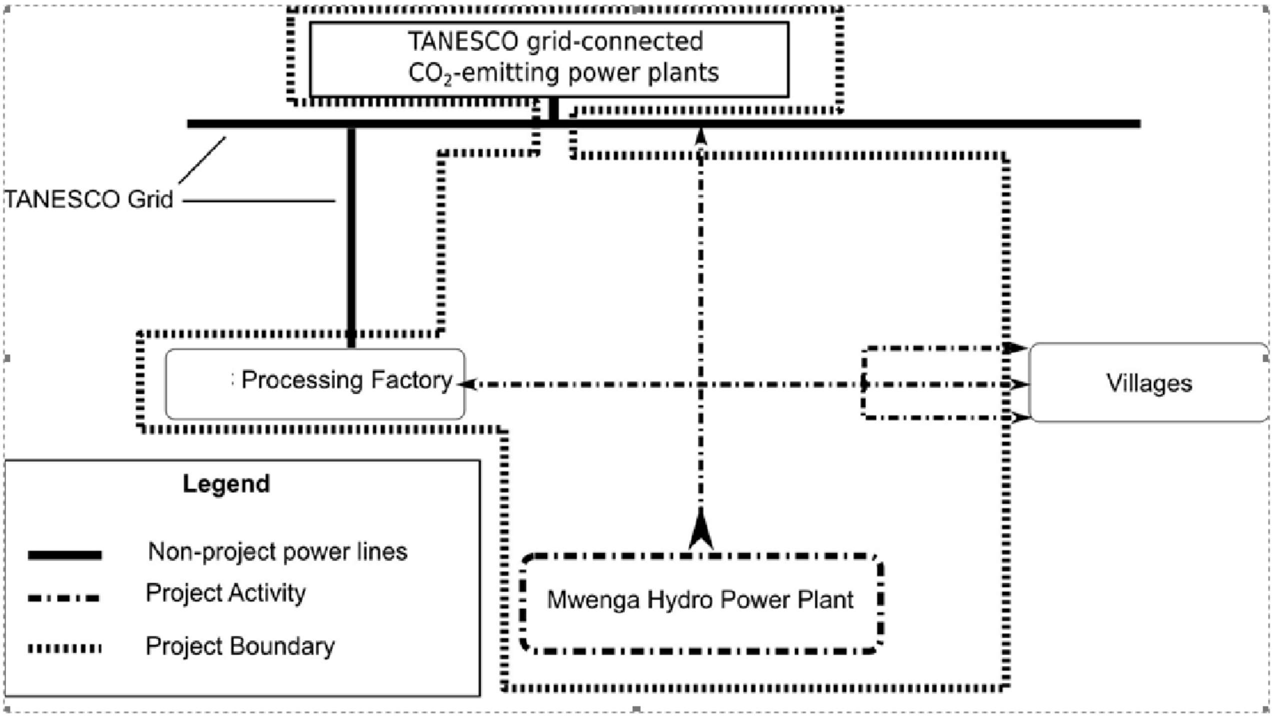
Electricity produced by the Hydropower plant is transported along a 49.7 km 33 kV line to the grid interconnection point located just outside the MTC Processing Factory. A number of villages along the path of this line are connected and it is currently estimated that approximately 210 km of additional spur lines have now been installed for this purpose. An estimated 120 km of LV distribution lines have now been installed within the various target villages.

It is estimated that the amount of electricity to be consumed by the end users located in the various villages that will be fed by the Hydropower plant will be approximately 2,500 MWh/yr in the medium term. It is currently only about 1,300 MWh per year (based on the usage of our current 2700 connected customers over the last 12 months), but is rising steadily. The individual village transformer meters were installed during this monitoring period.

Interconnection with the TANESCO grid, for export into this grid, takes place at the Mufindi Tea Estate and at other processing factories.

This network is presented in a simplified form in Figure B.2.

[7] Mwenga Hydropower Environmental Impact Statement. July 2009. Nyinisaeli K Palangyo



Note – There are two processing factories involved for current monitoring period

Figure B.2. Simplified schematic diagram illustrating project electricity flow

The project was first interconnected with the TANESCO grid, commencing regular generation output, on the 1st September 2012. The registration date of the CDM activity and start of the crediting period is given as the 30th January 2013. The first monitoring period ran from 30th January 2013 to 29th January 2014, the second monitoring period ran from 30th January 2014 to 31st January 2016 and the third monitoring period ran from 1 February 2016 to 31st January 2018.

The project has completed the formal commissioning of the interconnection equipment needed to directly supply the Mufindi Tea and Coffee Company Ltd (MTC) from the network, and supply electricity directly to the MTC factory. Installation of the required interconnection equipment was completed on 07/09/2015, but a fault was found with a key switch, requiring a replacement part be made up and shipped from the UK. Commissioning of the equipment took place on 29/02/2016. The project activity starts supplying the electricity to MTC processing factory from May 2016.Also project activity was connected to Unilever other processing factory and starts supplying the electricity from Jan 2017 onwards.

There were no events that occurred during the course of the monitoring period which could impact on the applicability of the methodologies applied. The project owner confirms that there were no changes to equipment or project design made during any major or minor shutdown within the current monitoring period in question. Only routine machine adjustments were performed during the course of the monitoring period.

B.2. Post-registration changes

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

There have been no deviations from the registered monitoring plan or applied methodology in this current monitoring period.

B.2.2. Corrections

During this monitoring period, in addition to Mufindi Tea & Coffee Limited, the project activity has supplied electricity to Unilever Tea Tanzania Limited. In the registered PDD, Unilever Tea Tanzania Limited was not mentioned as a consumer of electricity from this project activity. Therefore, registered PDD has been amended to include Unilever Tea Tanzania Limited as a consumer of electricity from the project activity.

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

Not applicable

B.2.4. Inclusion of monitoring plan

Not applicable

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

Not applicable

B.2.6. Changes to project design

Not applicable

SECTION C. Description of monitoring system

The monitoring plan requires that the parameters indicated in PDD section B.7.1 be monitored for the purposes of CER calculations. However, for operations as a whole, and to provide a backup in case of meter failure at either relevant off-take point, MHL measures, with appropriate meters:

1) Total electricity produced from the power plant
2) Electricity delivered to processing factories ($EG_{BL,y,1}$)
3) Electricity delivered to TANESCO ($EG_{BL,y,2}$)
4) Electricity delivered to the villages at the transformer for each village. These village supply transformer meters, in conjunction with the total output meter, are used for internal auditing purposes to monitor residential meter accuracy and transmission or other losses, and additionally allow reconciliation of power produced and distributed, particularly in the case of meter failure at a given off-take point. These meters are not necessary to track output related to CERs provided that all other meters are in working order.

For $EF_{CO2,y}$, MHL attempts to obtain from TANESCO on an annual basis $EF_{CO2,y}$ data as calculated based on the most recent three years of available data. Failing this, MHL attempts to obtain from TANESCO or other reputable sources the weighted average emissions in tCO_2e/MWh in the applicable crediting year. In the event such data are not available, the most recently available figures are used. This is a conservative approach because the vast majority of grid power added by Tanzania since 2010 has been fossil fuel-based, and the majority of firmly planned future plants will be fossil fuel-based. Thus, in the absence of more current data, it is likely that a given GEF will likely cause an understatement of emissions reductions.

The following diagram indicates the metering points described in the Monitoring Plan.

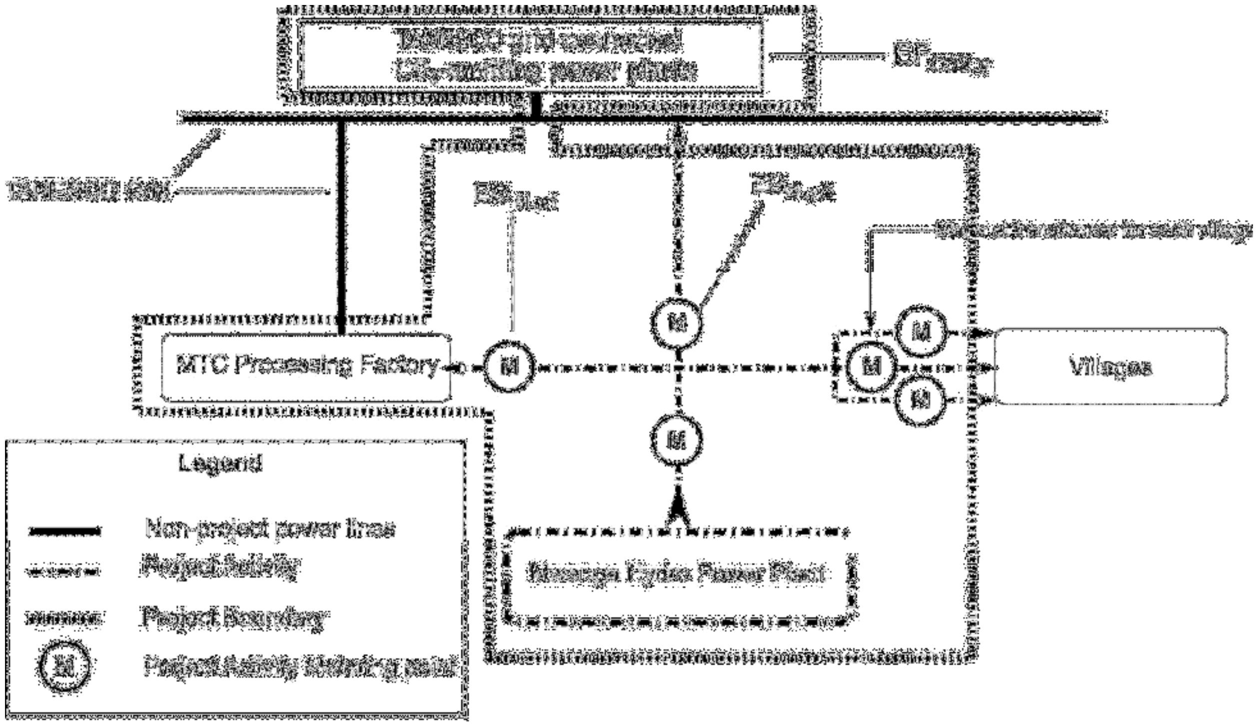


Figure C.1. Simplified Monitoring Diagram indicating location of metering points covered by the monitoring plan

Notes: Diagram is not to scale. There is a meter at the transformer from the project grid to each village. To keep this figure legible, only three village transformer meters are shown here. As noted throughout this document and the revised PDD, emissions reductions are not being claimed for villages because of the impracticality of establishing a valid baseline, thus, the villages fall outside the project boundary. As noted in parameters $EG_{BL,y,1}$ and $EG_{BL,y,2}$, the main plant meter and village transformer meters are monitored only as secondary checks against the processing factories and TANESCO meters, and are therefore included within the project boundary, but the village transformer meters are not required by the applicable methodologies: They are only necessary in case of failure of the main and check meters that are required by the applicable methodologies.

During this monitoring period neither the main nor check meters failed, therefore, the village meters were not necessary to accurately monitor production. Per AMS-I.D and associated guidance, grid-connected power plants with CO_2 emissions are included within the project boundary because they are used as the basis for calculating $EF_{CO2,y}$. Note that the project boundary does not include non-project power lines, because MHL is not responsible for building or maintaining them.

Metering devices enable the continuous measurement of the electricity supplied to meet the requirements of the processing factories, the TANESCO grid, and the villages. As noted above, because all main and check meters for output directed to customers within the project boundary were fully operational throughout the monitoring period, there was no need to resort to the village transformer meters within the CER calculations.

MHL is responsible for the installation, ownership and maintenance of the metering at the Delivery Point and Off-take Points for the villages and processing factories. TANESCO is responsible for the seals on the billing and check meter at the grid interconnection point.

The metering systems are designed such that the overall error of the metering installation, (including instrument transformers, wiring, and metering instruments) are in accordance with manufacturer specifications and national or IEC standards when available and applicable.

MHL have its main meter and the processing factories and village transformer meters tested and, if necessary, re-calibrated by an independent testing facility at least once every twenty-four months, or whenever MHL or one of its customers has reason to believe that the equipment is no longer performing within the applicable standards of accuracy given in the preceding paragraph. The calibration is performed by an individual or entity that is authorized to certify or otherwise attest that the meters have been calibrated in accordance with manufacturer specifications and national or IEC standards when available and applicable.

TANESCO have the main and check meters at the grid interconnection point re-calibrated at least once every twelve months. And if there is a deviation of 1% or more between the Billing meter and Check meter used to obtain data from the same source, then TANESCO investigates and calibrates immediately and will not wait for the annual calibration exercise. Both the main and check meter have an accuracy of 0.5% and both meters are bidirectional i.e. measure both export and import of power from the grid.

After completion of any such testing, MHL prepares a statement which constitute a record of the results of the testing carried out, and the extent to which the meters were performing outside the required limits of accuracy.

If, at any time, it is determined by the MHL or one of its customers as a consequence of a test or as is otherwise manifestly necessary that the meters should be replaced, then MHL shall arrange for a new meter to be furnished. Such action are recorded and the relevant documentation held.

The Operations Manager of MHL is responsible for the reading and recording of the respective kWh meter readings on the respective electricity meter(s) on the last day of each calendar month, along with the time of the reading, and the date of reading.

This data is entered into a hard copy book set aside for this purpose, and kept at the Operations Manager's office. Additionally this data is used to generate invoicing to the respective customers, and is also entered into a computer spreadsheet by the Operations Manager that mirrors this information. This file forms part of the monthly operations report of MHL. These physical and electronic records will be stored for at least two years after the later of the end of the crediting period or the last issuance of CERs for the project activity.

The Operations Manager is responsible for maintaining records of meter testing and any replacement, as well as any other information relating to the meters' operations.

Internal Audits are conducted annually under the supervision of the Director, Internal Audit of MHL's parent company. One internal audit was undertaken in current monitoring period, and covered all aspects of the business operation. These audits did not note any exceptions in the Carbon Credit compliance procedures.

Staff involved in monitoring and reporting are trained to ensure that the relevant monitoring and reporting procedures that need to be followed as part of the above monitoring plan.

Management is responsible for ensuring that staff responsible for monitoring and reporting have received adequate training.

MHL provides the necessary management structure and allocate responsibilities to staff to ensure that the above procedures are adhered to.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data / Parameter	**EG** $_{m,y}$
Unit	MWh
Description	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y*
Source of data	TANESCO
Value(s) applied	Refer to data series from TANESCO files hourly data in GEF spreadsheets.
Choice of data or Measurement methods and procedures	Data from TANESCO can be considered reliable
Purpose of data	To calculate Grid Emission Factor
Additional comment	The Simple Adjusted OM is calculated based on the Ex ante data vintages Option for the estimates appearing in the registered PDD. However, as stated in the Monitoring Plan, Ex Post monitoring shall be used

Data / Parameter	**EF** $_{EL,m,y}$
Unit	tCO_2e/MWh
Description	CO_2 emissions factor of power unit m in year *y*
Source of data	TANESCO
Value(s) applied	Refer to GEF calculation spreadsheet
Choice of data or Measurement methods and procedures	Calculated based on approach provided under Option A2 of the Simple OM method, using annual electricity generation, fuel type and efficiency for each power unit, *m*
Purpose of data	To calculate Grid Emission Factor
Additional comment	The Simple Adjusted OM is calculated based on the Ex ante data vintages Option for the estimates appearing in the registered PDD. However, as stated in the Monitoring Plan, Ex Post monitoring shall be used

Data / Parameter	**EF** $_{CO2m,i,y}$
Unit	tCO_2/GJ
Description	CO_2 emissions factor of fossil fuel type i used in power unit m in year y
Source of data	IPCC default values at the lower limit of 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	Natural Gas 0.0543 Gas/ diesel oil 0.0726
Choice of data or Measurement methods and procedures	No data for the fuels used in Tanzania is available hence IPCC defaults are used. For the calculation of the Simple Adjusted OM these figures shall be updated once, at the start of each crediting period in accordance with the applicable IPPC data at the time. For the BM these figures shall be updated once, at the start of each crediting period with the applicable IPPC data at the time.
Purpose of data	To calculate Grid Emission Factor
Additional comment	The Simple Adjusted OM is calculated based on the Ex ante data vintages Option for the estimates appearing in the registered PDD. However, as stated in the Monitoring Plan, Ex Post monitoring shall be used

Data / Parameter	η_y
Unit	Ratio
Description	Average net energy conversion efficiency of power unit m in year y
Source of data	TANESCO
Value(s) applied	Refer to GEF calculation spreadsheet
Choice of data or Measurement methods and procedures	Data from TANESCO can be considered reliable
Purpose of data	To calculate Grid Emission Factor
Additional comment	Weighted average was calculated based on weighted average of annual weighted average net conversion efficiency, i.e., (sum of each annual plant production * plant efficiency factor) / sum of total annual production. Each annual weighted average was then re-weighted as (sum of production in each year * annual applicable weighted average efficiency factor) / total production over three years. The Simple Adjusted OM is calculated based on the Ex ante data vintages Option for the estimates appearing in the registered PDD. However, as stated in the Monitoring Plan, Ex Post monitoring shall be used

Note in the registered PDD, parameters used to calculated the Grid Emission Factor (i.e. EG m,y, EF EL,m,y, EF CO2m,i,y and Average net energy conversion efficiency of power unit m in year y) are listed in section B.6.2. The Simple Adjusted OM is calculated based on the Ex ante data vintages Option for the estimates appearing in the PDD. However, as stated in the Monitoring Plan, Ex Post monitoring shall be used for Grid Emission Factor.

D.2. Data and parameters monitored

Data / Parameter:	**EG $_{BL,y,1}$**
Unit:	MWh
Description:	Net electricity generated by the Hydropower plant which is to be delivered to meet the requirements of the Processing Factory, but not including offset emissions from diesel backup generators
Measured / Calculated / Default:	Measured
Source of data:	Data will be collected in kWh on a monthly basis.
Value(s) of monitored parameter:	85.524 MWh for MTC 1862.478 MWh for Unilever
Monitoring equipment:	Iskra MT831-T1A32R46S43-E2-V22-M3K0Z4, serial number 35772910 (main meter), installed, to be tested biannually and calibrated in accordance with manufacturer specifications and IEC and/or national standards.
Measuring / Reading / Recording frequency:	Measured continuously, recorded monthly.
Calculation method (if applicable):	Not applicable

QA/QC procedures:	Data from MHL's main meter (Class 2 or better) compared with sales receipts and consumption figures obtained from meter readings taken at the Processing Factory. Data is physically collected monthly by MHL for billing purposes to processing factory via a joint meter reading process. This data is used to prepare the electricity bills to processing factory, which will be available for inspection from both processing factory head office and the MHL office as required. • Data to be archived electronically for at least 2 years after the later of the end of the crediting period or the last issuance of CERs for the project activity • Meters tested and, if necessary, re-calibrated at least once every twenty-four months or whenever a Party has reason to believe that the equipment is no longer performing to applicable IEC or national standards. MHL is responsible for testing and calibration. All testing and calibration are performed in accordance with manufacturer's specifications and instructions by an independent testing facility. Calibration certificates are issued and current and immediately previous certificates are kept on file at the MHL office for verification purposes.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

Data / Parameter:	**EG** $_{BL,y,2}$
Unit:	MWh
Description:	Net electricity generated by the Hydropower plant which is delivered to the TANESCO national grid
Measured / Calculated / Default:	Measured[8].
Source of data:	Monthly meter reading sheet of monthly billing and check meters installed at the TANESCO meter interconnection point
Value(s) of monitored parameter:	34,878.760
Monitoring equipment:	EDMI Mk10E Class 0.5, serial numbers 211309937 (main meter) and 211105245 (check meter), installed on 12th August 2012 and tested annually.
Measuring / Reading / Recording frequency:	Monthly
Calculation method (if applicable):	Not applicable
QA/QC procedures:	• Data from MHL's main power station meter compared with sales receipts and consumption figures obtained from meter readings by TANESCO, and cross-checked against a check meter on the MHL side of the grid interconnection • Data archived electronically • Meters tested and re-calibrated at least once every twelve months or whenever a Party has reason to believe that the equipment is no longer performing to applicable IEC or national standards. TANESCO is responsible for testing and calibration of these meters as per Article 4 h) of the SPPA agreement. All testing and calibration performed in accordance with the manufacturers' specifications and instructions.
Purpose of data:	Calculation of baseline emissions
Additional comment:	-

[8] the import and export are measured separately, and the net is calculated from the measured parameters

Data / Parameter:	$EF_{CO2,y}$
Unit:	tCO_2e/MWh (the methodology tables specify tCO_2e/kWh, but MWh will be used as the denominator for compatibility with other parameters)
Description:	Grid emissions factor calculated in accordance with applicable UNFCCC methodologies, guidance, and requirements.
Measured / Calculated / Default:	Calculated
Source of data:	TANESCO hourly generation data, IPCC default values
Value(s) of monitored parameter:	0.5203 for 2016
Monitoring equipment:	
Measuring / Reading / Recording frequency:	Hourly by TANESCO, however yearly data has been considered for calculations
Calculation method (if applicable):	See GEF spreadsheet and worksheet; partial or leap years were extrapolated to years of 8760 hours.
QA/QC procedures:	Data from TANESCO are considered to be reliable.
Purpose of data:	Calculation of baseline emissions
Additional comment:	Calculated in accordance with methodology outlined in the Tool to calculate the Emissions Factor for an electricity system (version 2.2.0). Refer also to PDD section B.6.1.

D.3. Implementation of sampling plan

Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

Component # 1 The production and transport of electricity to meet the requirements of the MTC Processing Factory

During the monitoring period, the project completed the formal commissioning of the interconnection equipment needed to supply electricity directly to the processing factories.

Baseline Emissions from component 1 is summarized below.

Component # 2 Grid connected electricity generation

The baseline emissions are the product of the electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the hydropower plant multiplied by the grid emissions factor.

$BE_{y,2} = EG_{BL\,y,2} * EF\ CO_{2grid,y}$

Where:

$BE_{y,2}$ = Baseline Emissions in year y (tCO2) associated with component # 2

$EG_{BL\,y,2}$ = Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity and associated with component # 2

$EF\ CO_{2grid,\ y,2}$ = CO_2 emissions factor of the grid in year y (tCO_2/MWh) associated with component # 2

According to AMS-I.D version 17, the emissions factor of the grid is chosen to be calculated as a combined margin (CM), consisting of the combination of an operating margin (OM) and a build margin (BM), both of which are calculated according to the procedures prescribed in the "Tool to calculate the Emissions Factor for an electricity system", version 6.0.

The Tool provides the following stepwise procedure:

Step 1: Identify the relevant electricity systems

The project electricity system is defined by the spatial extent of the power plants that are physically connected to the project activity through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. These power plants are those that feed into the Tanzanian National Grid.

Tanzania imports power from Kenya and Uganda, but such electricity is fed to isolated grids and not to the National Grid i.e. not to the Project Electricity System. Hence these imports are not considered for the purpose of determining the OM emissions factor. TANESCO does not export electricity.

Thus the relevant electricity system comprises the Project Electricity system, ie the Tanzanian National Grid.

Figure E.1. Tanzanian Power Grid System

Step 2: Choose whether to include off-grid power plants in the project system (optional)

Option 1: "Only grid power plants are included in the calculation" is the option chosen

Step 3: Select a method to determine the operating margin

The calculation of the operating margin emission factor is based on one of the following methods:

(a) Simple OM
(b) Simple adjusted OM
(c) Dispatch data analysis (OM)
(d) Average (OM).

The simple OM method (option a) can only be used if low-cost/ must-run-resources constitute less than 50% of total grid generation in 1) average of the five most recent years or 2) based on long term averages for hydroelectricity production.

As shown below, in the case of the Tanzanian grid, low-cost/ must-run resources are hydro resources and these constitute less than 50% of total grid generation in an average of the five most recent years. Therefore option a) the Simple OM can be used.

Table E1: Power generated in the last 5 years

	2012	2013	2014	2015	2016
Hydro	1769	1685	2589	2104	2340
Thermal	3728	3834	3380	3924	4380
Total	5497	5519	5969	6028	6720
% hydro	32%	31%	43%	35%	35%
Average hydro	35%				

Source: TANESCO

The Simple OM is calculated based on the ex post Option, whereby the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring.

Step 4: Calculate the operating margin emissions factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

Low – cost /must run power sources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid.

According to this definition, the power plants that fit into this category in Tanzania are Hydro power plants.

The simple OM is calculated using Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit

$EF_{grid,OMsimple,y} = \Sigma_m EG_{my} \times EF_{EL,m,y} / \Sigma_m EG_{m,y}$

Where:
$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m = All power units serving the grid in year y except low-cost / must-run power units
y = The relevant year as per the data vintage chosen in Step 3

Determination of $EF_{EL,m,y}$

The CO_2 emissions factor of each power unit m ($EF_{EL,m,y}$) is determined by applying Option A2, since for each power unit *m*, only data on electricity generation and the fuel types is available. The power unit's emissions factor is thus determined from the CO_2 emissions factor of the fuel type used and the efficiency of the unit as follows.

$$EF_{EL,m,y} = (EF_{CO2,m,i,y} \times 3.6) / \eta_{m,y}$$

Where:

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,i,y}$	= Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$	= Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3

For 2016, the Simple OM is calculated as 0.5113 tCO_2e/MWh

Step 5: Calculate the build margin emission factor

Based on 2016 data, since the set of the most recent power plants built that generated 20% of the country's electricity is greater than the amount of electricity generated by the set comprising the five most recently built power plants, the former set of power plants is taken for the purpose of determining the Build Margin emissions factor.

The CO_2 emissions factor of each power unit m ($FE_{EL,m,y}$) is determined as per Option A.2 of Step 4 of the "Tool to calculate the emissions factor for an electricity system" Version 6.0.

$$EF_{EL,m,y} = (EF_{CO2,m,i,y} \times 3.6) / \eta_{m,y}$$

Where:

$EF_{EL,m,y}$	= CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)
$EF_{CO2,m,i,y}$	= Average CO2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO2/GJ)
$\eta_{m,y}$	= Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3

For 2016, the BM is calculated as 0.5292 tCO_2e/MWh

Step 6: Calculate the combined margin emissions factor

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times \omega_{OM} + EF_{grid,BM,y} \times \omega_{BM}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,,}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
ω_{OM}	=	Weighting of operating margin emissions factor (%)
ω_{BM}	=	Weighting of build margin emissions factor (%)

The weightings used are as follows: ω_{OM} = 0.5 and ω_{BM} = 0.5 for the first crediting period, and ω_{OM} = 0.25 and ω_{BM} = 0.75 for the second and third crediting periods.

For 2016 and 2017, the CM is considered as 0.5203 tCO_2e/MWh. Please refer emission factor excel sheet for calculation of emission factor.
The baseline emissions for both components are as below

BE = $(EG_{BL,y,1})* EF_{CO2,y,} + (EG_{BL,y,2})* EF_{CO2,y,}$
= (85.524+1862.478)*0.5203+ 34,791.04*0.5203
= 19,115 tCO_2e

Total baseline emissions = 19,115 tCO_2e

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

Given that the project activity is a small scale hydro project and doesn't result in a new reservoir, no project emissions occur on account of the decomposition of vegetative biomass.

Therefore, as outlined in the PDD section B.6.1 based on the methodologies AMS-I.F. and AMS-I.D.,

Total project emissions: 0

E.3. Calculation of leakage emissions

No leakage takes place because the generating equipment is not transferred from another activity. Therefore, as outlined in the PDD section B.6.1 based on the methodologies AMS-I.F. and AMS-I.D.,

Total leakage: 0

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	19,115	0	0	0	19,115	19,115

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)
19,115	22,739

E.6. Remarks on increase in achieved emission reductions

From section E.5 above, it is evident that the actual emission reduction for the current monitoring period is lower than the estimated emission reduction by 15.94%.

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Document information

Version	Date	Description
06.0	7 June 2017	Revision to: • 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: • 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: • 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 *F-CDM-MR* to *CDM-MR-FORM*; • 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).
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