ISHASHA 6.6 MW

SMALL HYDROPOWER PROJECT

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C-Quest Capital Malaysia Limited

Project Title	Ishasha 6.6 MW Small Hydropower Project
Version	02
Report ID	-
Date of Issue	17-08-2018
Project ID	1286
Monitoring Period	01-01-2016 to 30-04-2018
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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Summary description of the implementation status of the technologies/ measures (eg, plant, equipment, process, or management or conservation measure) included in the project

Ishasha Small Hydropower project is a 6.4 MW run-of-river hydropower plant located on Ishasha River, Kanungu district of Western Uganda (hereafter referred to as "the project"). The electricity generated will be transmitted to the Uganda Electricity Transmission Company Limited (UETCL), which operates the national grid system.

The project results in a reduction of anthropogenic emissions of greenhouse gas by displacing an equivalent volume of electricity that would otherwise be generated by the fuel-fired power plants tied to the national grid.

The project involves installation of a run-of-river hydropower plant system and the installed capacity is 6.4 MW. 6.4 MW is the plant design (electrical) capacity resulting from the coupling of two (2) "Francis" turbines each with a nameplate capacity of 3.4 MW and two (2) Leroy Somer synchronous generators, each rated at 4.0 MVA and operated at power factor of 0.8.

The project will harness water from the Ishasha River and deposit the water approximately 90 metres through a mild steel penstock of 1,140 metres to run two turbines located in a power house at the end of the penstock. The runoff water tailrace is channelled for a re-entry into the Ishasha River at a point less than 1.5 kilometres from the dam/weir location.

Relevant implementation dates

Event	Date
Start date of plant operation	06-03-2011
Registration of project activity at UNFCCC website	08-06-2012
1st monitoring period (VCS)	06-03-2011 to 30-06-2012
2nd monitoring period (CDM)	01-07-2012 to 31-10-2013
3rd monitoring period (CDM)	01-11-2013 to 31-12-2014
4th monitoring period (VCS)	01-01-2015 to 31-12-2015
5th monitoring period (VCS)	01-01-2016 to 30-04-2018

Total GHG emission reductions or removals generated in this monitoring period

The project results in a total emission reduction of 31,983 tCO_2e over the monitoring period of 1 January 2016 to 30 April 2018.

1.2 Sectoral Scope and Project Type

The project is categorized under type/category as below:

a) Sectoral scope: 01 - Energy industries (renewable - / non-renewable sources)

b) Type: I - Renewable energy projects

The project is not a grouped project.

1.3 Project Proponent

Organization name	Eco Power Uganda Limited
Contact person	Bhatiya Ranatunga
Title	CEO
Address	30/1 Bagatalle Road, Colombo, 3, Sri Lanka
Telephone	+94-11-4513470/1/2
Email	bhatiya@ecopower.lk

Organization name	C-Quest Capital LLC
Contact person	Ken Newcombe
Title	CEO
Address	1015 18th Street, NW Suite #730, Washington, DC 20036
Telephone	+1 202 416 2400
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1.4 Other Entities Involved in the Project

Not applicable.

1.5 Project Start Date

06-03-2011 (which is the start date of plant operation)

1.6 Project Crediting Period

Start date of crediting period: 06-03-2011

End date of crediting period: 05-03-2021

1.7 Project Location

a) Host Party(ies): Republic of Uganda

b) Region/ State/ Province: Kanungu District of South-Western Uganda

c) City/ Town/ Community: Ruheza-Kyajura Village, Nyamigoue Parish in Kanyantoorogo sub-county

d) Physical/ Geographical location:

Location	Coordinates
Weir/Diversion Intake	-0.935556, 29.668611
Power House/Tailrace	-0.878611, 29.657500

1.8 Title and Reference of Methodology

Methodology: AMS I.D version 17 - Grid connected renewable electricity generation
Tool: Tool to calculate the emission factor for an electricity system" (version 02.2.1)

1.9 Other Programs

Participation under Other GHG Programs:

The project was registered under the CDM on 8 June 2012 with CDM reference number 6381. Under the CDM, the project was granted a fixed crediting period of 10 years from 1 July 2012 to 30 June 2022.

1.10 Sustainable Development

The primary objective of the project is to supply affordable electricity and contribute to environmental and economical sustainability for the population of Uganda. The electricity grid in Uganda supplies only a small fraction of the population and relies partly on fossil fuels. During the peak demand hours the fossil fuel use is very heavy. Increased production of electricity from renewable resources will lead to the reduction of the global emissions of greenhouse gases. The project will further help Uganda to stimulate and commercialize the use of grid connected renewable energy technologies. The project will demonstrate the viability of small scale grid connected hydropower directed primarily at peak hour service which can support improved energy security, improved air quality, improved local area livelihoods and sustainable renewable energy industry development.

It is estimated that the project will lead to an annual emission reduction of 21,084 tCO_{2e} annually.

The project will:

- Produce renewable energy and thus reduce global greenhouse gas emissions;
- Help to stimulate the small hydropower industry in Uganda;
- Create local employment during the construction and operation of the hydropower station;
- Reduce other pollutants such as particulates, SO_2, and NO_X resulting from fossil fuel power generation industry in Uganda;
- Reduce Uganda's increasing energy deficit; and
- Reduce import dependency.

The project contributes to sustainable development in Uganda in the following ways:

- Hydropower presents various environmental benefits compared to other primary energy sources: hydropower does not result in emissions of pollutants into the atmosphere nor does it emit residuals that can have a negative impact on soil, vegetation, drinking water etc. As a renewable energy source hydropower can be sustainably used by future generations. The proposed project will also contribute to a reduction in emissions other than GHG emissions related to conventional electricity generation, such as emissions of sulphur dioxide, nitrogen oxides, and particulates:
- The project will diversify Uganda's energy mix which comprises of biomass, petroleum and electricity. According to the energy balance 2006, final energy consumption is as much as 92.1% biomass, plus 7.0% petroleum products but only 0.9% electricity;[1]
- The project will result in additional employment opportunities, especially during the construction phase. Construction materials for the substantial quantum of concrete used for the project and access roads will be sourced locally;
- The project complies with national and local laws and regulations. The project has been granted a permit to develop the Ishasha small hydropower plant by the Electricity Regulatory Authority (ERA) and the Environmental and Social Impact Assessment (ESIA) has been approved by the National Environment Management Agency (NEMA);
- The project supports the main policy goal of the Ministry of Energy and Mineral Development; namely "To establish, promote the development, strategically manage and safeguard the rational and sustainable exploitation and utilization of energy and mineral resources for social and economic development".[2]

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The implementation of the project consists of construction of the following main items:

- A dam/diversion weir which rises 15 meters above the water level in the Ishasha River to allow sufficient water storage of about 44,000 cubic meters to operate the plant at full capacity approximately for 2 hours.
- Intake Structure
- A 1,140 meters in length penstock laid along the ground on concrete supports or buried in some areas from the intake to the power house
- A power house with a floor area of approximately 200m^2
- A power house with two horizontal 3.4 MW Francis turbines each coupled to a 4.0 MVA synchronous generator operated at a power factor of 0.8 to produce the plant design electrical capacity of 6.4 MW. The detailed technical specification of turbine and generator are listed as below.

Turbine specifications:

Quantity	2
Manufacturer	Turboinstitut
Type	Francis turbine

[1] Annual Report 2006, Ministry of Energy and Mineral Development, page 32
[2] Annual Report 2006, Ministry of Energy and Mineral Development, page iii

Model	TF 196TI-0.79-750
Serial Number	TF 1362/1, TF 1362/2
Net Head	91 m
Discharge	4.1 m^3/s
Turbine Speed	750 rpm
Turbine Output	3400 kW

Generator specifications:

Quantity	2
Manufacturer	Leroy Somer
Type	Synchronous generator
Model	LSA 56 UL9-8P
Serial Number	602328-1, 602328-2
Power Rating	4000 kVA
Power Factor	0.8
Power Output	3200 kW

- A tailrace canal and related structures back to the Ishasha River
- A transformer station and a 7 km 33kV transmission line
- Access roads
- Staff quarters

The project was implemented and operated in accordance with the registered PDD. The project consists of one site only and the implementation is not phased. The project started the operation on 6 March 2011. During the monitoring period, the project activity was in normal operation. There was no events or situations occurred which may impact the applicability of the methodology.

The downtime of the plant that occurred during the monitoring period is given in the table below.

Month	Downtime (hour)	Month	Downtime (hour)	Month	Downtime (hour)
Jan-16	617.80	**Jan-17**	1021.05	**Jan-18**	1101.32
Feb-16	662.87	**Feb-17**	927.24	**Feb-18**	1063.37
Mar-16	818.38	**Mar-17**	986.84	**Mar-18**	1097.81
Apr-16	684.27	**Apr-17**	1043.13	**Apr-18**	511.41
May-16	650.09	**May-17**	1219.21		
Jun-16	747.79	**Jun-17**	1194.75		
Jul-16	892.21	**Jul-17**	1176.52		
Aug-16	961.26	**Aug-17**	1140.90		
Sep-16	919.04	**Sep-17**	771.31		
Oct-16	726.81	**Oct-17**	890.23		
Nov-16	730.76	**Nov-17**	859.76		
Dec-16	876.28	**Dec-17**	965.24		

2.2 Deviations

2.2.1 Methodology Deviations

Not applicable.

2.2.2 Project Description Deviations

There is no project description deviation applied during this monitoring period.

The first project description deviations was approved by CDM EB on 24-04-2015. The brief description of the deviations is as below.

a) As per the registered PDD, the project was to be implemented for a design capacity of 6.6 MW. 6.6 MW is the plant design (electrical) capacity resulting from the coupling of two (2) "Francis" turbines each with a nameplate capacity of 3.4 MW and two (2) synchronous generators, each rated at 4.0 MVA and operated at power factor of 0.825.

During the actual implementation, the capacity implemented was slightly different from what was registered. This is due to the operation of generators at lower power factor of 0.8. As a result, it produces the plant design capacity of 6.4 MW only.

Power Plant	Capacity indicated in the registered PDD (MW)	Actual installed capacity (MW)
Uganda	6.6	6.4

The above-mentioned change in the project design does not alter the scale of the project and compliance to the applicability conditions of the applied methodology. The reduction in total installed capacity of the project is only reduced by 0.2 MW or 3% from the capacity stated in the registered PDD. The change in the design pertains to small variation in capacity does not adversely impact the additionality and the appropriateness of the baseline scenario of the project.

b) The Load Factor of the plant has changed from the one described in the registered PDD. The change is described in the table below.

Power Plant	Plant Load Factor applied in the registered PDD	Plant Load Factor applied in the revised PDD
Uganda	50.86%	56.36%

The change in the plant Load Factor does not impact the additionality and scale of the project. The change also has no impact on the applicability/ application of methodology under which the project has been registered.

c) In the registered PDD, the Main Meter and the Check Meter system are to be installed, owned, and maintained by EPUL. During actual implementation, the responsibility on meter maintenance has been transferred from EPUL to UETCL. The change took place since the plant started to operate.

d) The information about calibration frequency of meter is not provided in the registered monitoring plan. As per manufacturer specification, the recommended calibration frequency is every 5 years.

The second project deviation was approved by CDM EB on 07-02-2017. The brief description of the deviation is as below.

a) The information for ex ante parameter of "CO_2 emission factor of the grid, $EF_{CO2,grid,y}$" was included in Section B.6.2 of registered PDD.

2.3 Grouped Project

Not applicable.

2.4 Safeguards

2.4.1 No Net Harm

Full Environmental and Social Impact Assessment (ESIA) studies were carried out for the project. The ESIA Report deals with the potential environmental and social impacts of the project and fulfills the legal requirements for an Environmental Impact Assessment for the Project.

The identified potential negative social impacts reported in the ESIA for the project include:

1) The project does not require any resettlement. Only 2 households were possibly to be affected and a successful attempt was made to avoid their removal by careful location of the project access roads. The land to be used by the project is all essentially agriculturally productive or bare land, but given the number of farmers and the size of the plots cultivated, no individual landholder will lose more than 10% of the productive holdings to the project. The site construction work will temporarily disrupt additional farming but much of the land temporarily put out of service will be available for agricultural purposes after construction completion. This enabled an equitable cash-for-land arrangement to be proposed to and be accepted by the community. The resettlement payments for agricultural land or crop loss as mutually agreed to have been paid already under the terms of the agreed Resettlement Action Plan that will be available to the Validation Team.

2) Compensation is being paid to 36 claimants for loss of land and crops. Approximately 40 acres of land will be required for the project. Compensation at rates determined by local government authorities has been paid to all persons for loss of land and crops.

3) The project will also entail a reduced flow in a 2 km stretch of the Ishasha River. This will potentially affect water quality, riverbank vegetation, birds, fish populations and other aquatic life, but in a minimum way since there will always be a 250 liter a second flow release through the

dam to mitigate the harm potential as directed by NEMA and the Directorate of Water Development.

4) The project will attract migrant labor during the construction period that historically brings with it increased potential for social issues connected to the spread of HIV/AIDS and other sexually transmitted diseases. These potential impacts can be minimized by implementing proper awareness programs at and around the site.

5) The construction period will entail increased traffic in an area not used to traffic concerns. The risk of pedestrian accidents is real in this case. Speed control, pedestrian awareness, and diver awareness programs will be needed.

6) The agricultural land to be taken over by the project is generally on rather steep slopes is barren of vegetation and this will lead to run-off and loss of valuable topsoil and deteriorating river water quality if not mitigated. EPUL will be responsible for planting native species in an appropriate way on such land to protect the land and the water resource of the river.

2.4.2 Local Stakeholder Consultation

The local stakeholder consultation was carried out in April 2007 involving all of the relevant stakeholders and in particular the indirectly and directly involved population in the Kanungu District in southwest Uganda. Additional stakeholder meetings were held on 7 June 2008 and 23 August 2008. The outcomes from the local stakeholder consultation is available in Section E of the PDD[3].

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{CO2,grid,y}$
Data unit	t CO_2/MWh
Description	CO_2 emission factor of the grid
Source of data	Registered PDD
Value applied:	0.6673
Justification of choice of data or description of measurement methods and procedures applied	Ex-ante option as per the “tool to calculate the emission factor from electricity system” version 02.2.1.
Purpose of the data	Calculation of baseline emissions
Comments	-

[3] https://cdm.unfccc.int/UserManagement/FileStorage/SA6E5BLI9FZVY80C4HR1J2D3ONKUQT

Data / Parameter	**$FC_{i,m,y}$, $FC_{i,j,y}$, $FC_{i,k,y}$**
Data unit	Mass or volume unit
Description	Amount of fossil fuel type i consumed by power plant / unit m, j, of k in year y
Source of data	Utility official publications, collected from UETCL
Value applied:	See PDD Appendix 4
Justification of choice of data or description of measurement methods and procedures applied	• OM: Most recent 3 historical years of data that were available at the time of validation are 2006 – 2008. BM: For the first crediting period one time calculations following the appropriate guidance
Purpose of the data	Baseline emission calculations
Comments	Calculation of simple adjusted OM in cases where fuel consumption data is available for all power plants/units

Data / Parameter	**$NCV_{i,y}$**
Data unit	GJ / mass or volume unit
Description	Net calorific value (energy content) of fossil fuel type i in year y
Source of data	IPCC default values at the lower limit of uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value applied:	IPCC Standard for diesel/distillate is 41.4 TJ/10^3tonnes IPCC Standard for Residual Fuel Oil is 39.8 TJ/10^3tonnes
Justification of choice of data or description of measurement methods and procedures applied	Neither values from fuel supplier nor regional / national values are available and the IPCC default values are used.
Purpose of the data	Baseline emission calculations
Comments	Applicable in calculation of the simple OM, the simple adjusted OM and the average OM in cases where fuel consumption data is available for all power plants / units, as per EF calculations in Section B.6.3 of PDD.

Data / Parameter	**$EF_{co2,i,j}$ and $EF_{co2,m,i,y}$**
Data unit	tCO_2/TJ
Description	CO_2 emission factor 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 applied:	IPCC Standard for diesel/distillate is 72.6 tCO_2/TJ IPCC Standard for Residual Fuel Oil is 75.5 tCO_2/TJ
Justification of choice of data or description of measurement methods and procedures applied	Neither values from fuel supplier nor regional / national values are available and the IPCC values are used.
Purpose of the data	Baseline emission calculations
Comments	Applicable in calculation of the simple OM, the simple adjusted OM and the average OM in cases where fuel consumption data is available for all power plants / units, as per EF calculations in Section B.6.3 of PDD.

Data / Parameter	**$EG_{m,y}$, $EG_{j,y}$, $EG_{k,y}$**
Data unit	MWh
Description	Net electricity generated and delivered to the grid by power plant / unit m, j, k, or n (or in the project electricity system in case of EGy) in year y
Source of data	Most recent 3 years data (2006 – 2008) collected from Electricity Regulatory Authority (ERA) and Uganda Electricity Transmission Company Limited (UETCL)
Value applied:	See PDD Appendix 4
Justification of choice of data or description of measurement methods and procedures applied	• OM: Most recent 3 historical years of data that were available at the time of validation are 2006 – 2008. BM: For the first crediting period one time calculations following the appropriate guidance.
Purpose of the data	Baseline emission calculations
Comments	-

Data / Parameter	***Cap*** $_{BL}$
Data unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity. For new hydro power plants, this value is zero.
Source of data	Project site
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Determine the installed capacity based on manufacturer's specifications or recognized standards.

Purpose of the data	Calculation of project emissions
Comments	-

Data / Parameter	A_{BL}
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero.
Source of data	Project site
Value applied:	0
Justification of choice of data or description of measurement methods and procedures applied	Measured from topographical surveys, maps, satellite pictures, etc.
Purpose of the data	Calculation of project emissions
Comments	-

3.2 Data and Parameters Monitored

Data / Parameter	EG_y
Data unit	MWh
Description	Annual electricity supplied by the project to the grid
Source of data	1) Monthly joint meter reading reports by UETCL and EPUL.[4] 2) Monthly sales invoices issued by EPUL to UETCL for the electricity sales invoicing and payment.[5]
Description of measurement methods and procedures to be applied	The data has been measured continuously using meter and recorded on a monthly basis from the monthly invoices.
Frequency of monitoring/ recording	Monthly

[4] The report provides the present readings of monthly electricity generation and consumption.

[5] The value of meter reading indicated in the invoices is the **net electricity supplied** (export minus import) to the grid.

<table>
<tr><td>Value monitored</td><td>47,960.26 (before adjustment)
47,932.34 (after adjustment due to delay in meter calibration)</td></tr>
<tr><td>Monitoring equipment</td><td>Two-way hourly meter.

Meters M_1 and M_2 as described in Section 3.3 are Main Meter and Check Meter respectively. The calibration frequency of the meter is every five years.

<table>
<tr><th>Meter</th><th>Type</th><th>Serial Number</th><th>Accuracy class</th><th>Calibrated on</th><th>Valid till</th></tr>
<tr><td rowspan="2">Main meter, M_1</td><td rowspan="2">CEWE Prometer W</td><td rowspan="2">CW001303</td><td rowspan="2">0.2s</td><td>18/12/2010</td><td>17/12/2015</td></tr>
<tr><td>14/06/2016*</td><td>13/06/2021</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="2">Check meter, M_2</td><td rowspan="2">CEWE Prometer W</td><td rowspan="2">CW001304</td><td rowspan="2">0.2s</td><td>18/12/2010</td><td>17/12/2015</td></tr>
<tr><td>15/06/2016*</td><td>14/06/2021</td></tr>
</table>

*Delay in calibration of both meters during the monitoring period was observed in between 01/01/2016 to 13/06/2016 (Meter M_1) and 14/06/2016 (Meter M_2) respectively. The subsequent calibration which was scheduled on 14/06/2016 and 15/06/2016 respectively, confirmed that the percentage of error found was within the maximum permissible error (0.2%) of the meter. Thus, the meter was working well within the permissible limits.

As the conservative approach in emission reductions calculation, the electricity export for the month of January to June 2016 has been reduced by the maximum error of 0.2% while the electricity import also has been increased by the same percentage of error.</td></tr>
<tr><td>QA/QC procedures to be applied</td><td>There will always be a back-up meter in service in case of a main meter failure. The monthly net power supply to the grid will hence be the sum of all monthly meter readings.

Meter calibration will only be necessary if the difference in reading between the main and check meters deviates by more than 1.5%.</td></tr>
<tr><td>Purpose of the data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>-</td></tr>
</table>

Data / Parameter	***Cap*** $_{PJ}$
Data unit	MW
Description	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data	EPUL
Description of measurement methods and procedures to be applied	Determine the installed capacity based on manufacturer's specifications or recognized standards.
Frequency of monitoring/recording	Yearly
Value monitored:	6.4
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	-.
Comments	-

Data / Parameter	***A*** $_{PJ}$
Data unit	m^2
Description	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data	EPUL
Description of measurement methods and procedures to be applied	Measured from dam reservoir layout.
Frequency of monitoring/recording	Yearly
Value monitored:	9,608
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of the data	Calculation of project emissions
Calculation method	-
Comments	-

Environmental and Social impacts

These parameters have no impact on emission reduction calculation and have been monitored in-line with the registered PDD.

The main environmental concern required EPUL always allow 250 litres (0.25 m^3) per second of river water to pass through an open pipe at the bottom of the dam such that there will always be an adequate flow of water in the section of the river between the diversion and the tailrace, especially during the dry season.

As observed in Environmental Audit Report, the environmental flow pipes of required dimensions had been installed into the dam infrastructure and it allows a release of 0.250 m^3 of water to the river all the time. To avoiding any situation where the flow will be reduced during dry spells, five pressures values have been installed just above the environmental flow pipe. This will enable the plant operator to maintain the required volume of free environmental flow by turning on the pressure values.

For the social impacts, a positive aspect of the project is through employment of local people. Below are the employment details as on April 2018.

	Apr-18
Employee category	**Number of Employees**
Engineer	1
Liaison Officer	1
Power House Operator	3
Power House Assistant	10
Accounts	1
Plant Supervisors	2
Total	**18**

3.3 Monitoring Plan

Data collection procedures and metering

Electricity generation data is the main input variable for the calculation of emission reductions and it is monitored via metering approach. Eco Power Uganda Ltd (EPUL) is responsible to meter in the dual meter system. There is only one line and the dual meter is two-way hourly meter, so each meter reading is a net reading of power exported from or imported to the power station. There will always be a back-up meter in service in case of a main meter failure. The monthly net power supply to the grid will hence be the sum of all monthly meter readings.

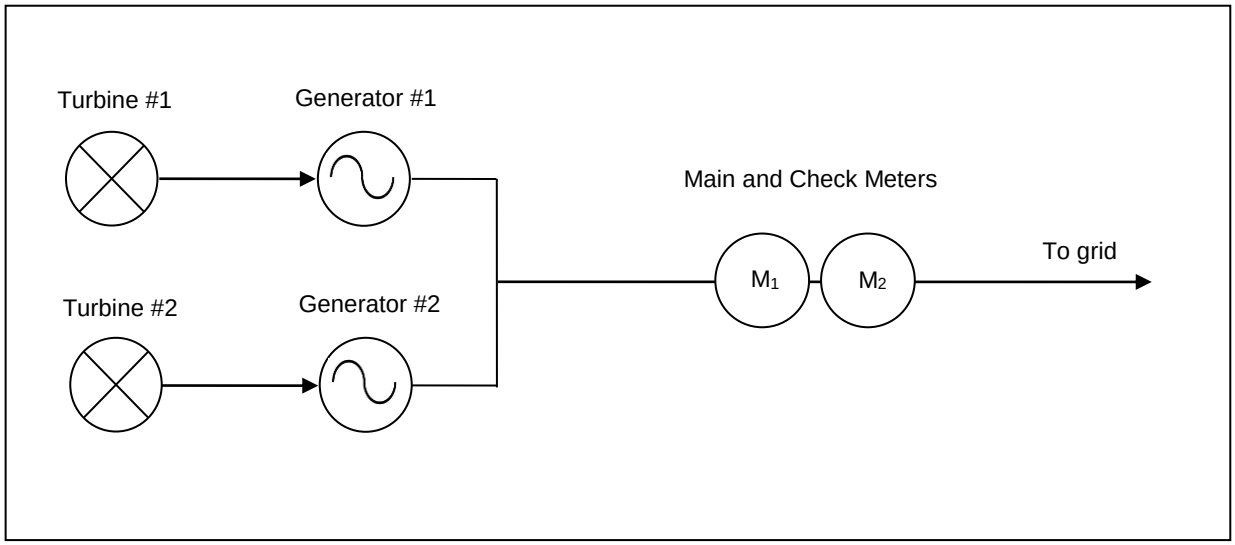
The Main Meter (Meter M_1) and the Check Meter (Meter M_2) system installed, owned and maintained by UETCL, is designed such that the overall measurement system error (including instrument transformers, wiring, and metering instruments) shall be no greater than 0.2% (special UETCL requirement). The metering system shall provide 3 separate meter readings based on the supply period defined below:

Supply Period	**Hours**
Off peak hours	0000 to 0600 hours
Shoulder hours	0600 to 1800 hours

Peak hours	1800 to 2400 hours

The Main and Check Meters specified in the PPA shall be installed in a metering and control chamber to be provided by EPUL in a mutually agreed position as shall be agreed upon by the Parties as soon as it is practically possible and the said Meters shall be sealed by each Party using their own seals. Sealing and breaking of the seals shall be witnessed by a representative of each of the Parties.

The line diagram below shows the metering points for the project.



Organizational structure, roles and responsibilities

A Project Manager is appointed to be responsible for the overall monitoring system and reporting of all relevant issues which occurred in the monitoring activities. An Operational Manager is assigned to assist the Project Manager for the monitoring of monthly electricity generation and liaise with the electricity purchaser, UETCL, to correct any discrepancies of measurement according to the requirements and direction of the Power Purchase Agreement (PPA).

The Operational Manager will report to the Project Manager and coordinate with UETCL on a monthly basis, and the figures confirmed by both as accurate will be used for reporting emission reductions.

Emergency procedures for the monitoring system

If there is any failure of the meters, the site technician will notify the grid company and CDM manager.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The baseline emissions are calculated as per formula below.

$BE_y = EG_y \times EF_{CO2,\ grid}$

Where:

BE_y	Baseline Emissions in year *y* (t CO2)
EG_y	Annual electricity supplied by the project to the grid (MWh)
$EF_{CO2,\ grid}$	CO2 emission factor of the grid (t CO2/MWh)

a) Quantity of net electricity supplied to the grid

Month	Quantity of net electricity supplied to the grid according to the supply period (kWh)			Total net electricity supplied to the grid (kWh)
	Peak hours	Shoulder hours	Off Peak hours	
Jan-16	907,480	1,202,040	553,000	**2,662,520**
Feb-16	707,430	1,125,600	459,680	**2,292,710**
Mar-16	732,280	938,600	386,850	**2,057,730**
Apr-16	795,880	975,430	506,660	**2,277,970**
May-16	780,980	1,164,840	643,260	**2,589,080**
Jun-16	667,940	1,031,120	374,300	**2,073,360**
Jul-16	644,670	884,210	281,190	**1,810,070**
Aug-16	518,210	716,350	245,380	**1,479,940**
Sep-16	487,320	783,140	302,330	**1,572,790**
Oct-16	690,270	1,121,080	559,580	**2,370,930**
Nov-16	650,800	1,091,740	466,040	**2,208,580**
Dec-16	638,070	868,550	335,840	**1,842,460**
Total	**8,221,330**	**11,902,700**	**5,114,110**	**25,238,140**

Month	Quantity of net electricity supplied to the grid according to the supply period (kWh)			Total net electricity supplied to the grid (kWh)
	Peak hours	Shoulder hours	Off Peak hours	
Jan-17	512,250	684,030	178,430	**1,374,710**
Feb-17	466,720	607,390	158,120	**1,232,230**
Mar-17	553,080	743,790	230,750	**1,527,620**
Apr-17	454,070	606,360	149,370	**1,209,800**
May-17	322,980	374,710	97,930	**795,620**
Jun-17	319,770	330,520	79,430	**729,720**

Jul-17	380,430	491,490	80,030	**951,950**
Aug-17	448,860	547,530	144,580	**1,140,970**
Sep-17	631,640	977,040	493,490	**2,102,170**
Oct-17	666,530	707,760	506,870	**1,881,160**
Nov-17	600,830	829,270	417,300	**1,847,400**
Dec-17	531,270	817,990	297,770	**1,647,030**
Total	**5,888,430**	**7,717,880**	**2,834,070**	**16,440,380**

Month	**Quantity of net electricity supplied to the grid according to the supply period (kWh)**			**Total net electricity supplied to the grid (kWh)**
	Peak hours	**Shoulder hours**	**Off Peak hours**	
Jan-18	426,030	593,270	187,590	**1,206,890**
Feb-18	338,130	414,540	108,110	**860,780**
Mar-18	408,210	547,780	288,510	**1,244,500**
Apr-18	869,180	1,347,320	753,070	**2,969,570**
Total	**2,041,550**	**2,902,910**	**1,337,280**	**6,281,740**

b) Adjustment on Jan to Jun 2016 electricity output due to delayed meter calibration

Month	**Monthly export**			**Monthly import**			**Net monthly Output (kWh)**
	Total monthly export (kWh)	**Deduction for Non Calibration of Meter**	**Adjusted monthly export (kWh)**	**Total monthly import (kWh)**	**Addition for Non Calibration of Meter (kWh)**	**Adjusted monthly export (kWh)**	
Jan-16	2,662,690	5,326	**2,657,364**	170	1	**171**	**2,657,193**
Feb-16	2,292,930	4,586	**2,288,344**	220	1	**221**	**2,288,123**
Mar-16	2,057,970	4,116	**2,053,854**	240	1	**241**	**2,053,613**
Apr-16	2,278,220	4,557	**2,273,663**	250	1	**251**	**2,273,412**
May-16	2,589,260	5,179	**2,584,081**	180	1	**181**	**2,583,900**
Jun-16	2,073,590	4,148	**2,069,442**	230	1	**231**	**2,069,211**
						Total	**13,925,452**

Total net monthly output from Jan to Jun 2016

Before adjustment: 13,953,370 kWh

After adjustment: 13,925,452 kWh

Reduction on electricity output due to delayed meter calibration: 27,918 kWh

Total electricity supplied to grid from Jan to Dec 16: **25,238,140 kWh**

Deduction on electricity output due to delayed meter calibration: 27,918 kWh

Net electricity supplied to the grid = 25,238,140 – 27,918

= **25,210,222 kWh**

c) Calculation of emission reductions

The ex-ante grid emission factor as per the registered PDD is 0.6673 t CO_2/MWh.

EG_{2016} = 25,210,222/1000

= 25,210.22 MWh

BE_{2016} = 25,210.22 MWh x 0.6673 t CO_2/MWh.

= **16,822 tCO_2e** (after rounded down)

EG_{2017} = 16,440,380/1000

= 16,440.38 MWh

BE_{2017} = 16,440.38 MWh x 0.6673 t CO_2/MWh.

= **10,970 tCO_2e** (after rounded down)

EG_{2018} = 6,281,740/1000

= 6,281.74 MWh

BE_{2018} = 6,281.74 MWh x 0.6673 t CO_2/MWh.

= **4,191 tCO_2e** (after rounded down)

4.2 Project Emissions

As per AMS I.D. ver 17, the project emissions from water reservoirs of hydro power plants have to be considered following the procedure described in the most recent version of ACM0002.

If the power density of the project activity (*PD*) is greater than 10 W/m^2, PE = 0

The power density of the project activity (*PD*) is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}}$$

Where:

PD	Power density of the project activity (W/m^2)
Cap_{PJ}	Installed capacity of the hydro power plant after the implementation of the project activity (W)
Cap_{BL}	Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero
A_{PJ}	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)
A_{BL}	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero

PD = (6.4 – 0) MW

(9608 – 0) m^2

= 666.11 W/m^2

The power density of the project activity (*PD*) is greater than 10 W/m^2, therefore the project emission can be ignored.

Thus, PE= 0

4.3 Leakage

There are no leakage emissions associated.

4.4 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
Jan 2016 to	16,822	0	0	16,822

Dec 2016				
Jan 2017 to Dec 2017	10,970	0	0	10,970
Jan 2018 to Apr 2018	4,191	0	0	4,191
Total	31,983	0	0	31,983