Sri Lanka® Carbon Crediting Scheme

Carbon Management Assessment (CMA)

Maduru Oya Left Bank Canal Sluice Small Scale Hydropower Project

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Project Title	Maduru Oya Left Bank Canal Sluice Small Scale Hydro Power Project
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Project proponent/s	Eagle Power (Pvt) Ltd
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1. Description of Project Activity

1.1. Introduction of Project Activity

The proposed small scale hydro power project is located, in association with the existing Left Bank Sluice of Maduru Oya Reservoir, owned by Mahaweli Authority of Sri Lanka. Maduru Oya reservoir project was completed in the year 1984, under Mahaweli Program, for the provision of irrigation water, to a vast area of land in downstream. The left Bank sluice, off taking water for the irrigation system is located in a left area saddle dam, having a bulk head gate at the entry with trash raking arrangement, guard gate and control gate at outlet, to regulate the water discharges to the canal. During the construction stage of Maduru Oya reservoir provision has been made providing 2 penstock outlets from the main conduit of the sluice barrel to install hydro power machines for power generation. Proposed power house of the project will be constructed adjoining to the left side of the existing the sluice, where the provision has been made by demarcating the pit area to construct the power house using the penstock outlets. As the capacity of the proposed power plant will be limited to the sluice water issues, due to partial development of the downstream irrigation system, present power development has been limited to 5000 kW power plant. According to the hydrological calculation 15.99 GWh will be generated, which will be connected to the national grid located few meters away from the site.

Project alternatives are limited, as the existing infra-structure has to be utilized. If the outlet pipes are to be extended to obtain a higher head, a tunnel to be excavated along the left bank area of the existing canal to drop near Kuda Oya siphon area. This is a costly and not environmentally feasible proposal. Use the outlets, which have already been provided and diverting the water back after the power generation directly to the main canal is a most feasible proposal for the proposed project. The project area is not environmentally sensitive since it already has been disturbed by human activities since the inception of the Mahaweli irrigation system. The environment of the area is a disturbed grassland and secondary forest vegetation. No unique flora or fauna exist in the area.

Considering the hydro power potential at LB sluice MASL invited the applications from Project Proponents having technical and financial capacity to undertake the Project. Eagle Power (Pvt) Ltd. has been selected as the prospective project proponent and the Letter of Intent (LOI) was issued jointly by MASL/CEB on January 2007 limiting the installed Capacity to 5 MW.

Maduru-oya left bank sluice hydro power project has been constructed in association with the Dam of the Maduru Oya reservoirs and the penstock lines off taking from the existing sluice conduit. It's the first regulated water way small-scale hydro power project undertaken along a waterway of Mahaweli Authority, with private sector participation.

Capacity of the project is 5 MW and the annual average output is 15.99GWh.

This Power plant started operations in 2011.

Project	Proposed Installed Capacity	Expected Energy Output	Project Cost & IRR
Maduru Oya Left Bank Canal Sluice Small Scale Hydro Power Project	5000 kW	15.99 GWh	MSLRs 585 16.0 %

As the civil works have been completed to a greater extent project is financially feasible even after paying a royalty of 34.2 % from the income of the generated power to MASL. Project is feasible as water is assured to meet the irrigation water demand for farmers.

Parameters Related to the Proposed Power Project

Hydrology

Maximum discharge observed	36.11 cumecs
Minimum discharge observed	1.01 cumecs
Average mean discharge	19.55 cumecs
Reservoir active capacity	476.3 mcm
Volume obtains from own catchment	248 mcm/annually
Volume obtains from diversion	550 mcm/annually
Rainfall	1000 – 4000 mm

Reservoir water level (head) variations

Maximum water level at the reservoir	96.0 m msl
Minimum operating level	84.5 m msl
Outlet canal water level	78.0 m msl
Head variations considered	18 ~ 6 m
Designed head	16.5 m

Proposed power plant

Installed Capacity	5.0 MW (as proposed in LOI)
Expected Energy Output	15.99 GWh annually
Type of the turbine	Dual operation Kaplan – Vertical
Efficiency of the flow variation	60%
Generation	Synchronous/semi umbrella type
Generating Voltage	6.6 kV
Frequency	50 Hz
Line of connectivity and Voltage	300 m/ 33 kV

Cost and financial status

Total Project Cost	585 m SLRs
Equity of the Project Proponent	30 %
Lending Banks	70 %
Internal Rate of Return	> 16%
Royalty to MASL	34.2 % from generated power

Operational conditions

Water operations	as per MASL seasonal operating plans/RPM sys ‘B’ directives

Electro – Mechanical Equipment Selection

Existing Arrangement

Proposed Power House will be located in the left bank sluice area adjacent to the irrigation outlet structure. Water for the power generation is through a common intake located up stream of the dam. Provision has been made to divert water through 2 steel lined conduits off taking from the main irrigation outlet. The two branch conduits leading to power station are 2.6 m in diameter and closed temporary at present.

Criteria on Turbine Selection

Project potential head and discharges for power generation can be classified as high discharge and low head category. As the head is low high specific speed units are required to convert the major part of the potential energy to convert to kinetic energy in front of the runner. It is essential for minimizing friction by selecting an efficient draft tube to meet the high specific speed unit. For this purpose, the possibility of performing accurate model test in an accepted laboratory is important. The guarantee of performance to be confirmed only after the model tests to check the specific speeds and its losses on output efficiency. Other main factors are hydraulic torque on guide vanes due to large variations on positioning and its functioning through servo motors, runner blade torque, runaway speed to meet the required dimensions of units, as well the hub size and to determine the hydraulic thrust at different operating conditions. According to the conditions of the location Kaplan or bulb turbine is suited.

Advantage of Selection of a Kaplan or Bulb Turbine

Kaplan turbine	Bulb turbine
Wider load range with better part of load efficiency from 100 – 20 %	Low construction work on civil and other assembly work
Higher synchronous speed to reduce the lag time on switching on	High efficiency on large change in load variations
Hydraulically suited for large head variations	Smaller runner diameter and built in unit

Kaplan Turbine

As per the conditions available for power generation with varying head and discharges for irrigation water supply vertical shaft Kaplan turbine is more suitable to the proposed project. Its cost effective and its repair and maintenance works are much less. Kaplan turbine with steel spiral case has been finalized to install and the draft rube will be of single pier elbow type.

Turbine designs will be carried out by the selected supplier considering the any head variation from minimum net head to maximum net head without undue vibration. Head variations are from 18 m – 6 m for the project but its smooth due to large reservoir volume. Kaplan turbine is efficient for head variations and the blades are adjustable for pitch in full dual Kaplan type machines to handle variations of flow efficiently.

Relationship between the blade angle and the guide vane opening will be maintained automatically over the operating range of the turbine by a combinatory or runner blade control mechanism which is actuated by the governor. Draft tube will consist of steel plate liner extending from the turbine discharge ring to the downstream tangent point of the elbow. Arrangements will be made to close the draft tube with stop logs during high surges of the canal. Due to strong pressure on turbine, it is necessary to mount the runner below tail race level.

Governor

In order to maintain the turbine speed within the specified limits governor operation will be through a hydraulic actuator coupled to speed sensor or frequency sensor. For the project it is necessary to ensure run away speed to be maintained at 750 rpm and interlocking with voltage sensing unit to prevent load switching, if turbine speed falls below specified limits

Governor will be of electro – hydraulic of the tacho accelerometric type with unit equipped with sump tank, pressure tank, two oil pumps and the necessary auxiliaries for control of the turbine. Controls will be arranged so that either pump may be operated to supply the normal operational requirement or the second pump into operations. This depends on the predetermined values of the oil pressures variations.

Turbine Inlet Valve

The diameter of each inlet penstock is 2.6 m a butterfly valve operated through a hydraulic servo motor. Valve will be installed immediately upstream of the turbine spiral casing and closing speed will be low in order to reduce the surge pressure on the penstock. The valve operating system will incorporate a hydraulic pump, oil sump, electrically operated control valves and a counter weight to ensure gate remains open under normal running conditions. This valve needs automation to meet the discharges as per the directives given by MASL on irrigation water releases. For last 10 years flow variations are made on weekly basis mainly but observed some 2 – 3 days variations.

The discharges are varying due to 2 factors viz,

- to increase or decrease the valve opening due to water level variation in the reservoir
- Variations on water releases to meet the irrigation water requirement

Existing inlet bulk gate modifications will be considered to meet any emergency requirement as irrigation water issues cannot be interrupted.

Generator Cooling System

The method of cooling of the generator will depend on the design characteristics of the generator. Forced air cooling or water-cooling systems are standard. However cooling water for the generator will be provided from penstocks and released to the tail race. A booster pump and a by-pass arrangement will be made for the system.

Generator control and power conditioning system

The CEB requires the generation system to satisfy certain conditions with respect to the following;

- Voltage regulation
- Voltage limits at the point of connection (33KV), within which the system should function during normal operation conditions.
- Power factor for the connection, which will be typically unity, but may be leading, depending on voltage regulation issues. Specified valve with limit of variations will be considered to design the control unit of the generator.
- Earthing of generator and feeder network. Impedance earthing or arc suppression coil earthing of transformer secondary windings supplying networks having an operating voltage of 33 KV.
- Impedance or solid earthing of the transformer secondary winding, when supplying CEB network with an operating voltage of 11 KV.
- Solid earthing of transformer secondary winding providing customer low voltage supplies or supplying LV networks.
- Parallel earthing when operating in parallel with CEB electricity supply network and provide safer generator connections.

CEB do not encourage islanded operation. The switching system at Point of Supply will carry appropriate equipment to prevent islanding for prolonged periods. However, because of the remoteness of the generating location from the main substation, islanded operation possibilities will be discussed with CEB. In such a situation earthing and protection system may have to be revised.

Compressed air systems

Small capacity compressor will provide governor air system. Station service air system will supply to the generator braking system. This arrangement will be included in the system designs.

Oil purifying, dewatering and fire protection

A portable oil purifies will be installed to purify insulated oil, lubricating oil and hydraulic system oil for all power plant equipment. For drainage purposes a sump will be provided at tail race entry with automatic controlled pumping units. Valve connection unit will be provided for spiral case and draft tube dewatering. Provision will be made to operate at the inlet valve pit. Fire extinguisher system will be provided with specific discharges as specified.

Generator

Generator will be a semi – umbrella type synchronous one connected with a vertical shaft to the turbine through a gear box system. It's in static excitation operation mode rated at 6600 volts, 3 phase, 50 Hz, and 2.5 MW at 0.9 power factor. Insulation is class F on epoxy resin bonded.

Power transformer

Three phase, 50 Hz power transformer adequately rated will be installed to step up the voltage from 6600 V to 33 KV. Off load tp changers will be provided on the high voltage side of the transformer will full capacity taps at – 10% to + 10% above normal voltage on the high and low voltage side at rated voltage.

Auxiliary transformer

A 6600 V /440 V three phase 200 kVA, 50 Hz auxiliary transformer will be provided at the power house, for the supply to the auxiliaries of the power house.

Switchyard and Transmission

Switchyard will be located at the higher ground location as shown in the map and will be a 33 KV outdoor type. The generated power will be connected to Manapitiya - Mahiyangana 33 KV sub transmission line through the switch yard. The distance of the proposed transmission line is less than 300 m.

Parameter of Project and E & M equipment

Hydrology

Reservoir full supply level	96.0 m msl
Minimum operating level	84.5 m msl
Maximum observed discharge	36.11 m^3/sec
Designed discharge	22.0 m^3/sec
Head variation	18 ~ 6 m

Turbine Inlet valve

Type	Butterfly

Diameter	2.6 m

Turbine

Type	vertical shaft – Kaplan
Maximum net head	18.0 m
Minimum net head	06.0 m
Rated net head	16.0 m
Rated speed	350 rpm
Runaway speed	750 rpm
Power at rated head	2500 kW
Power at the maximum loading	3000 kW
Sense of rotation	anti clockwise

Generator

Phase	Three
Frequency	50 Hz
Rated Voltage	6600 V
Maximum output	3000 kVA
Power factor	0.9 lead or lag
Synchronous speed	350 rpm
Runaway speed	750 rpm

Main transformer

Frequency	50 Hz
Phase	three
Rated voltage	6.6 kV/33kV
Rated output	3000 kVA
Power factor	0.9 lead or lag
Off lo dap changer	- 10% to + 10% in steps of 5%

The estimated annual power generation output of this small hydropower plant is 15.99 GWh which is exported to the national electricity grid of Ceylon Electricity Board. This replaces an equal amount of fossil fuel dominated power in the National Grid.

Prior to this project activity, there was no hydropower plant belonging to project participant in that region. Hence the project can be considered as a Greenfield project activity. Baseline scenario for this project activity will be the electricity from the grid.

1.2. Sectoral Scope and Project Type

Sectoral scope 1, Type I, AMS-I.D "Grid connected renewable electricity generation"

1.3. Project Proponent

Organization Name	Eagle Power (Pvt) Ltd
Contact Person	Kapila Wijesekara
Address	No 09, Modarawila Industrial Zone, Panadura.

Title	Director / General Manager
Telephone	0773822454
Fax	0384282780
E-mail	kapila@ethimale.lk

1.4. Other Entities Involved in the Project

Organization Name	Anunine Holdings (Pvt) Ltd
Role in the project	Mother company of Eagle power (Pvt) Ltd
Contact Person	G.A. Sithara Sewwandi
Address	77, Sri Saranankara Rd, Dehiwala-Mount Lavinia.
Title	Sustainability Analyst
Telephone	0703672748
Fax	-
E-mail	sithara@anunine.com

1.5. Location of Project Activity

Management of the Project area is vested with MASL, which includes land, other natural resources and social infrastructures. On behalf of MASL the Resident Project Manager (System B) and Maduru Oya Dam Site Engineer Headworks Division have been vested the authority to manage the project and in general;

- Province - North Central Province
- District - Pollonnaruwa
- DS Office - Dimbulagala
- Pradeshiya Saba - Dimbulagala
- GN Office - 239, Alawakumbura
- Village - Alawakumbura

The project site is located at 339 km from Colombo.

Location of Project Activity	Maduru Oya Left Bank Main Canal Sluice
Province	North Central Province
District	Plonnaruwa

DS Division	Maduru Oya
City/Town	Aralaganwilla
Community	Alawakumbura
Coordinates	Latitudes - 7^0 66' 69.43'' N Longitudes - 81^0 19' 77'' E

Figure 1: Location map (Source: Google map)

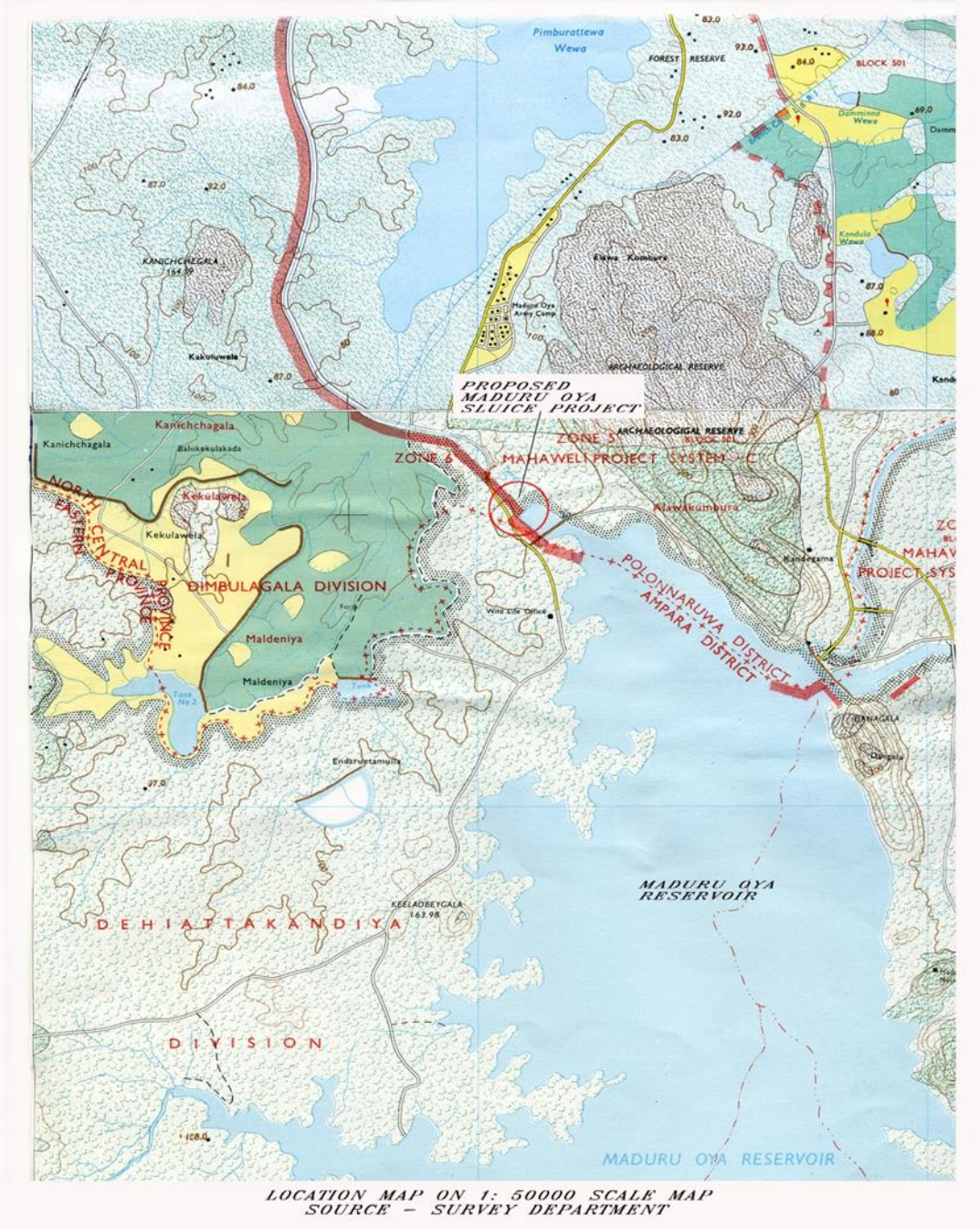


Figure 2: Location Map (Source: Survey Department)

1.6. Project Ownership

The project is fully owned by Eagle Power (Pvt) Ltd.

1.7. Project Fundings

No any funds capitalized on the development of this project.

1.8. Project Start Date

Starting date of the Maduru Oya Left Bank Canal Sluice Small Scale Hydropower Project activity is **12th August 2008 (**This was the date when first real action was taken by PP and Letter of Award for construction of access road to the power house was made along with the advance payment to the contractor**)**

1.9. Project Commissioning Date

The project was successfully commissioned on 17th June 2011.

1.10. Project Track

The Maduru Oya Left Bank Canal Sluice Small Scale Hydropower Project intends to be registered under track II and issued carbon credits from project will only be used for internal offsetting of emissions.

1.11. Project Crediting Period

The project's initial crediting period spans from the 1st of March 2021 to the 28th of February 2028, covering a total of 7 years and allowing for renewal. It should be noted that at the commencement of the first crediting period, 9 years have already elapsed within the project's overall lifespan. As a result, the renewable crediting period for the project will be restricted to two periods of 7 years each, commencing from the 1st of March 2021. This may be validated at the renewal of the crediting period of the project activity.

1.12. Scale of Project and Estimated Emission Reduction

Project Scale

Small	√
Large	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021.03.01-28.02.2022	12,014
2022.03.01-28.02.2023	12,014
2023.03.01-29.02.2024	12,014
2024.03.01-28.02.2025	12,014
2025.03.01-28.02.2026	12,014
2026.03.01-28.02.2027	12,014
2027.03.01-29.02.2028	12,014
Total estimated ERs	84,098
Total number of crediting years	7
Average annual ERs	12,014

1.13. Description of the Project Activity

This project has introduced new proven environmentally safe technology imported from England. Therefore, this project will help transfer the technology from eastern countries to the country.

This project has been using an environmentally safe and sound technology while contributing the improvement of the environment through reducing the emissions from thermal power plants such as SO_x and NO_x pollution in addition to the reduction of CO_2 emission.

Most of the equipment such as turbine, alternator, electrical switchgear etc. has been imported from China and India. All civil works were carried out using locally available materials.

1.14. Conditions Prior to Project Initiation

In the pre-project scenario, there were no any hydropower plant belonging to project participant in that region and this plant is “Greenfield" plant. Therefore, electricity producing by new power plant should have to be produced using fossil fuel consumed power plants since further exploitation of large-scale hydro resources are difficult due to social, economic and environmental impacts associated with the development.

The baseline in the absence of the construction of the new hydropower plants is electricity from grid.

Eagle Power Project	Technical specification		
General	Catchment Area		490 km^2
	Average Annual Catchment Rainfall		1000 mm – 2000 mm
	Average Flow		19.55 m^3/s
	Gross Head		16.5 m
	Installed Capacity		5 MW
	Mean Annual energy generation		15.99 GWh
Weir1 (Main Weir) & Intake	Type		Existing Mahaweli Dam
	Max. Height		N/A
	Length		N/A
Outlet Channel	Type		Reinforced concrete,
	Length		20 m
	Height		4 m
	Inner Width		20 m
	Flow depth at design flow		3 m
	Hydraulic slope		.001
Penstock	Type		Single welded steel pipe
	Length		50 m
	Inner diameter		2.6 m X 2
	Gross Head		16.5 m
Powerhouse	Size of Building		30 m x 13 m x 15 m
	Hydraulic Turbine	Type	Dual Operation Kaplan – Vertical (2500 kW x 2)
		Rated Flow	16.5 m^3/s X 2
	Generator	Type	Synchronous, 6.6kV
		Operating Speed	300RPM

1.15. Compliance with Laws, Statutes and Other Regulatory Frameworks

In terms of regulations in Sri Lanka, small scale hydropower projects require approval from the Central Environment Authority (CEA) which looks at both environment and social aspects. In order to get the approval developer should prepare an Environmental Impact Assessment (EIA) report and submit to the CEA. This EIA report corresponds to a TOR provided by the CEA and CEA visits the site with a team of experts and grants approval for the project if they are satisfied, after obtaining all necessary clarifications.

The project developer has already obtained Environmental Clearance from the CEA. The preliminary findings of the EIA reflect that the adverse environment impacts of this project are negligible. No significant mitigatory measures are required for this project.

1.16. Participation under Other GHG Programs

This project has not registered, or is seeking registration under any other GHG programs and this was not rejected by other GHG programme.

1.17. Other forms of Credit

This project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates.

1.18. Sustainable Development

This renewable electricity generation facility is able to reduce the contribution from thermal electricity generation to meet the electricity demand. Unlike in thermal power plants, this project will positively contribute to the electricity demand without compromising the ability of future generations to meet their own needs. Therefore, this renewable energy project is a positive step toward sustainable development. The national sustainable development criteria are,

1) Environmental well-being

2) Economic well-being

3) Social well-being

4) Technological well-being

Environmental well-being

The project contributes to an improvement of the local environment through reducing emissions such as SO_x and NO_x from thermal power plants which have to be operated to generate an equal amount of power using thermal sources if this project is not implemented.

Economic well-being

Discontinuing the use of fossil fuel saves foreign exchange since the entire quantity of fossil fuel requirement is imported to the country.

Social well-being

Good amount of employment opportunities had been created for the local workforce during the project construction phase. The project after implementation provides employment opportunities for the local populace in a sustained manner over the project life time. The enhanced employment opportunities created by this project activity will lead to alleviation of poverty, and eradicate unemployment.

Technological well-being

This power plant has been erected as a fully automated power plant. The project activity has used of the reliable and proven technology available locally to ensure that an environmentally safe technology is only being implemented in this project activity.

1.19. Leakage Management

No any equipment or material transferring from outside for this project.

1.20. Commercially Sensitive Information

No commercially sensitive information has been included in this project scope.

2. Environment Impacts

2.1. Analysis of environmental impacts

In terms of regulations in Sri Lanka, small hydropower projects require approval from the Central Environmental Authority (CEA) which looks at both environmental and social aspects. Developers should prepare an Environmental Assessment Report and submit to the CEA for approval. CEA grants approval for the project if they are satisfied, after obtaining all necessary clarifications.

Then this project has received the Environmental Clearance from the CEA.

Hydropower plant	Capacity rating (MW)	Date of environment approval received from CEA
Maduru Oya Left Bank Canal Sluice Small Scale Hydro Power Project	5	31st December 2007

These clearances by CEA reflect the finding that the environment impacts of this project is negligible.

The general and specific conditions of approvals of the EAs are in most instances generic, i.e., guidance on minimizing impacts of site preparation. Also, all projects require an environmental monitoring plan that covers surface water (not relevant in practice for run-of-river projects), flora and fauna within the river and below the diversion point, river bank erosion, and sediments upstream of the weir.

The noteworthy specific condition to the project site is summarized below.

- No damage to the rock boulder deposits in the upstream area from the weir
- Maintain the downstream in proper condition, a continuous uninterrupted flow of 30 litres/sec shall be maintained
- Adhere to the approved trace of the transmission line route identified by the CEB
- Solid waste associated with the work force shall be disposed of in consultation with the local authority
- Shall adapt appropriate conservation methods to stabilize any disturbed slopes
- Sediments collected at the weir site and accumulated in the setting basin should be disposed in controlled manner
- Soil conservation techniques should be adapted in controlled manner

  Should be incorporated in the design at the mouth of intake to prevent entry of fish into conveyances system and build overpass of the open head race canal to facilitate movement of small terrestrial

2.2. Environmental impact assessment

The environmental impacts of this project are not considered significant.

3. Local Stakeholder Consultation

3.1. Stakeholder Consultation Process

There should be some public involvement to ensure that critical issues are identified and that local information about the project area is gathered and that alternative ways of achieving the project objectives are considered. Public involvement could be used to avoid biases inaccuracies in analysis to identify local values and preferences to assist in the consideration of mitigation measures and to select the best practicable alternative.

Eagle Power (Pvt) Ltd had expressed their plan to develop the proposed 5 MW grid connected project and called for the suggestions/comments of the local stakeholders. In line with the public notice, a meeting was held on 7th September 2005. Stakeholder consultation for the project activity has been conducted to account for the views of the people impacted either directly or indirectly due to the project activity as well as impact to the environment. This has been carried out at all levels of stakeholders

The stakeholder consultation process of Maduru Oya Left Bank Canal Sluice Small Scale Hydro Power Project started with the identification of most relevant stakeholders to the project. It was found that the several types of stakeholders with different social status were interested in the project.

3.2. Summary of Comments Received

Director and consultant of Eagle Power (Pvt) Ltd. made a detailed description of the project activity. A series of questions were raised by the participants and majority of them were focused on the possible environmental impacts. In response to them, consultant of project activity described the actions planned to be taken to prevent possible negative environmental impacts. Further the participants were presented with the credentials of stipulated environmental clearance obtained from the relevant authorities. Then villagers were more curious in knowing the advantages and benefits of the project. The participants were convinced that job creation and infrastructure development would be a key outcome of this project. With that insight, participants did not raise any objection against the development and implementation of the project.

3.3. Consideration of Comments Received

Not Applicable

4. Eligibility Criteria

4.1. General Criteria

Sub Section	Eligibility Criteria	Project Activity	Yes/No
4.1.1	The project activity shall be a new project, which will reduce/absorb GHG emissions or the project activity shall be a project, which was implemented on or after 2010 in order to offset GHG emission within the organization.	The project was implemented after 2010 and SCERs are used to offset in-house GHG emission.	Yes
4.1.2	The project activity shall be located in Sri Lanka.	The project is located in Sri Lanka	Yes
4.1.3	The project activity shall not happen in the absence of benefits received from trading Sri Lanka Certified Emission	SCERs are used for in-house offset	Not applicable

	Reduction units (SCERs). (This is not applicable Track II)		
4.1.4	The project shall be implemented voluntarily by the project owner but not implemented based on legislation or regulations in the country	This was a voluntarily implemented project activities and no any legislation from the country to implement this project activities	Yes
4.1.5	The project activity satisfies environmental standard and regulations of the country	This was a voluntarily implemented project activity and no any legislation from the country to implement this project activity	Yes
4.1.6	The project shall not have been registered under any other national or international scheme. However, if a registered project under other scheme is willing to register with SLCCS, then, such project shall be deregistered from the other scheme in order to be eligible	This project has not been registered under any other national or International Schemes	Yes

4.2. Bundling Criteria

This project is not identified as a bundle project. Hence, this section is not applicable.

5. Application of Methodology

5.1. Title and Reference of Methodology

AMS-I.D "Grid connected renewable electricity generation" Version 18.0

5.2. Applicability of Methodology

The project that is introduced in this report is a new hydro power project that is applicable under “clause 4 (a) Install a Greenfield plant” of the AMS I.D./Version 18/EB 81.

5.3. Project Boundary

The project boundary of Maduru Oya Left Bank Main Canal hydropower plant encompasses the physical, geographical site of the power plant and associated physical structure. The project boundary which includes fore bay tank, penstock, turbine and generator, control panel, transformer and national electricity grid of power plant pictorially presented below.

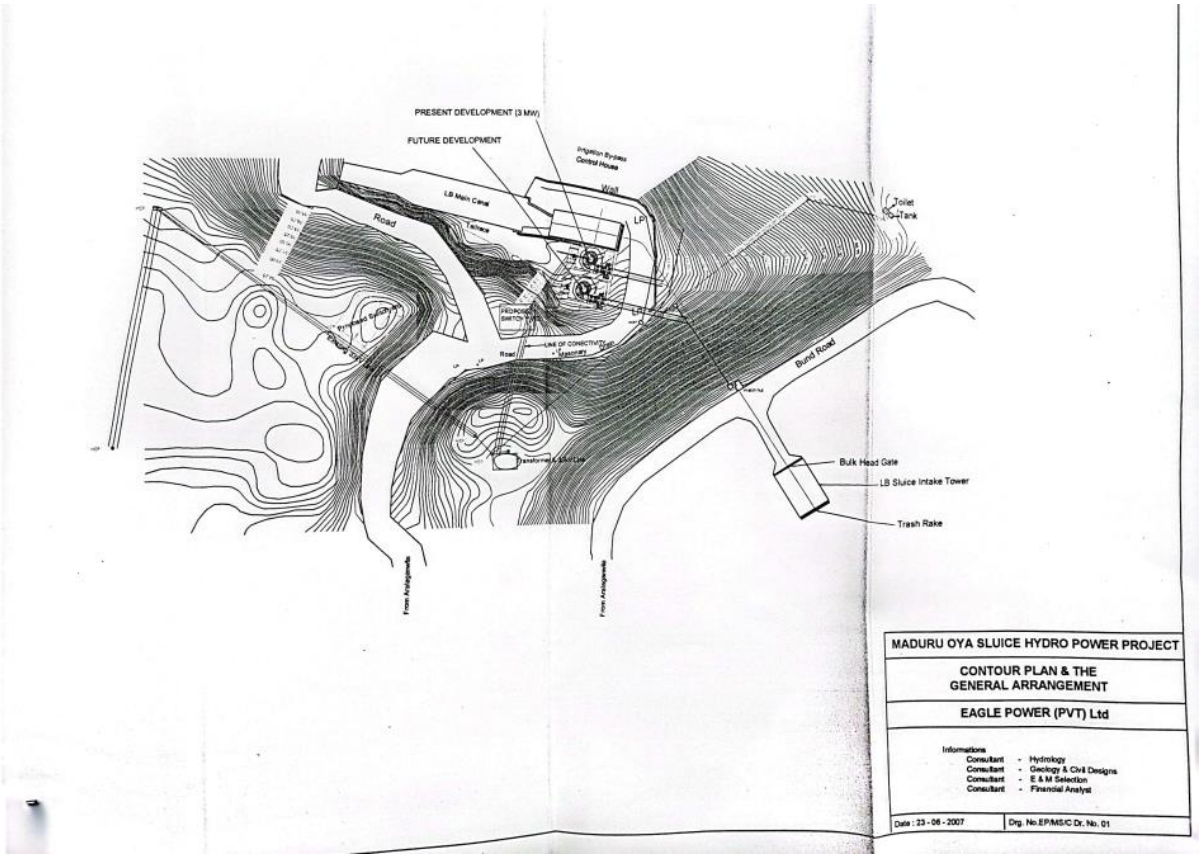


Figure 3 : Contour plan & the general arrangement

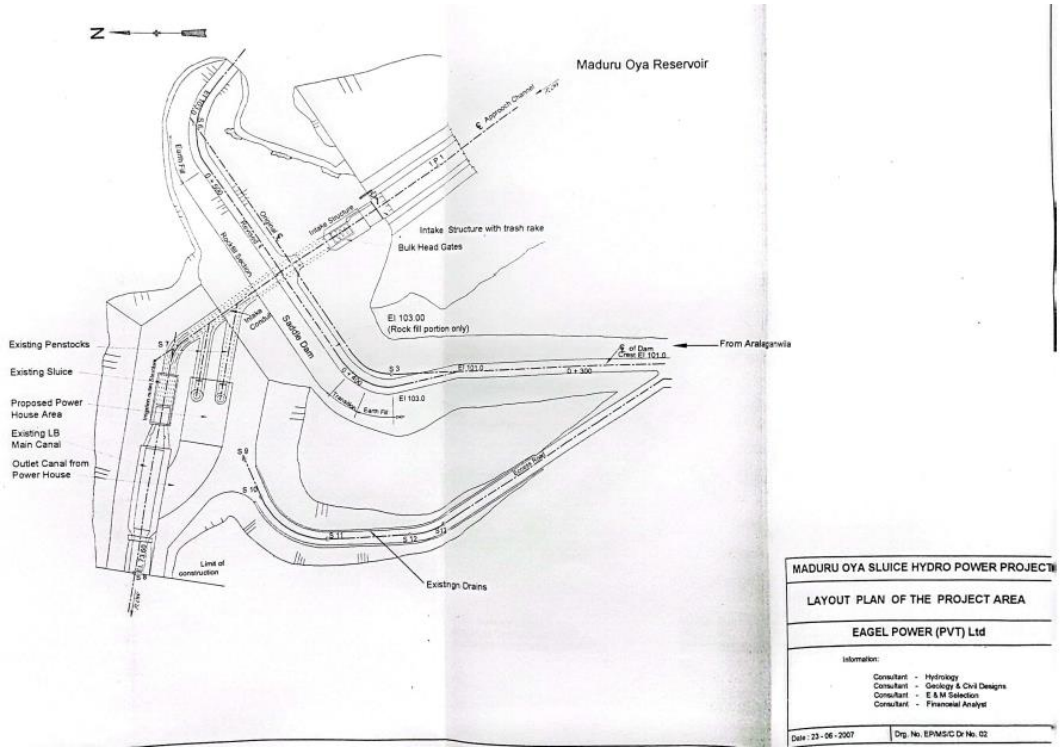


Figure 4 : Layout plan of the project

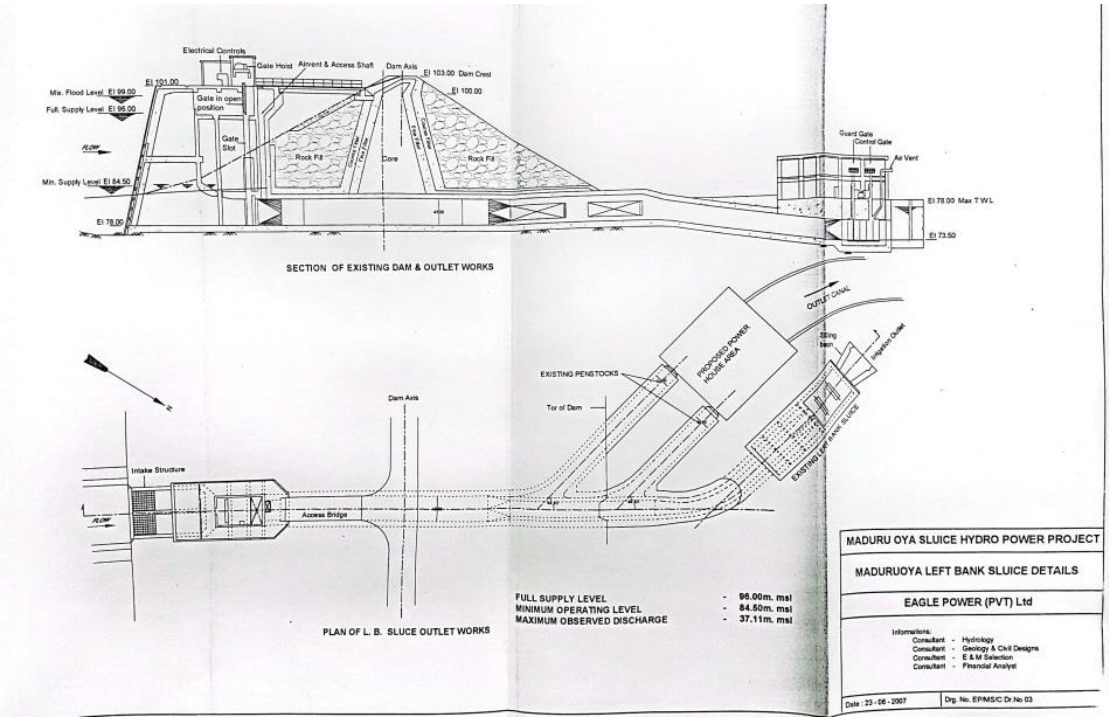


Figure 5: Maduru Oya Left Bank Sliuce project details

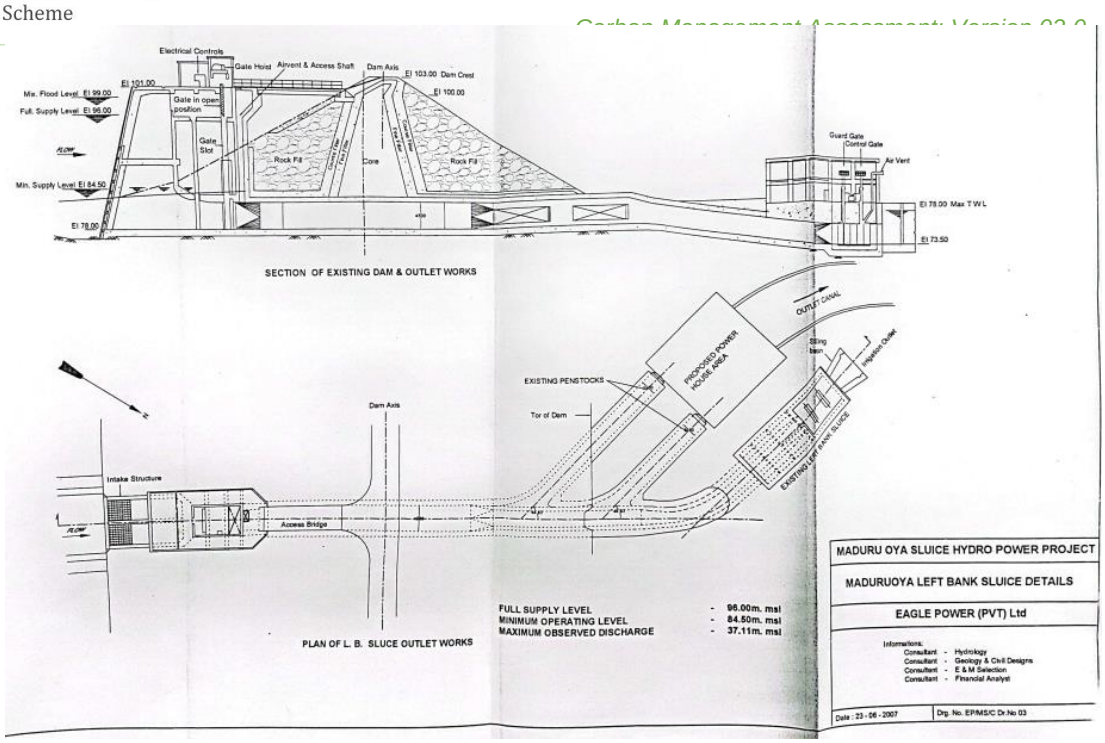


Figure 6: General arrangement of turbine / generator system

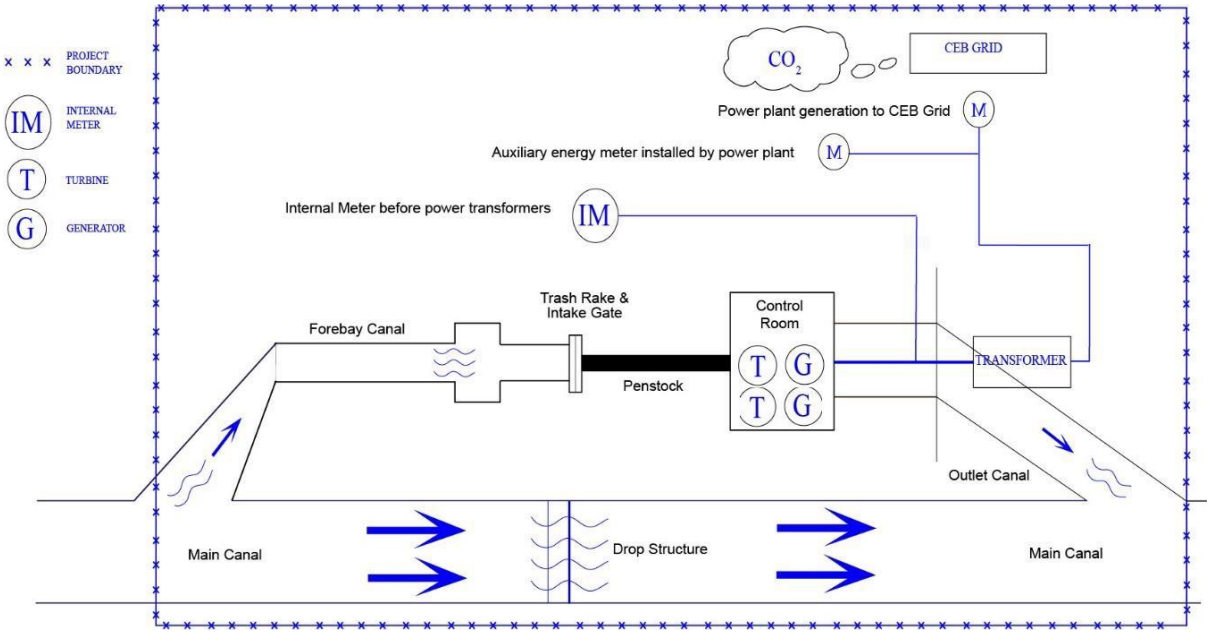


Figure 7: Project Boundary considered for the project activity

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from fossil fuel fired power plants connected to National Grid of Sri Lanka	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		Other	No	Minor emission source
Project		CO_2	Yes	Main emission source

Source		Gas	Included?	Justification/Explanation
	CO_2 emissions from burning of fossil fuel in on-site diesel generator	CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		Other	No	Minor emission source
	Emissions from water reservoirs of hydro power plants	CO_2	No	Minor emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
		Other	No	Minor emission source

5.4. Baseline Scenario

Prior to this project activity there was no hydropower plant at that location hence this is a greenfield plant. Absence of this project, the amount of electricity generated by the project should be produced using fossil fuel fired power plants connected to national grid. Therefore, the baseline is electricity produced by power plant connected to national grid.

5.5. Additionality

The project is intended to be registered under track II. Therefore, additionality is not necessary to be demonstrated.

5.6. Methodology Deviations

Not Applicable

6. Quantification of GHG Emission Reductions and Removals

6.1. Baseline Emissions

The baseline emissions are the product of electrical energy baseline $EG_{Bl,y}$ expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor.

$$BE_y = EG_{PJ,y} \times EF_{grid,y}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EG_{PJ,y}$	=	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)
$EF_{grid,y}$	=	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" (t CO_2/MWh)

Calculation of baseline emission factor

As per paragraph 22 of AMS I.D. Ver18.0, for project activities that do not displace captive electricity generated by an existing plant but displace grid electricity import and/or supply electricity to a grid, the emission factor of the grid shall be calculated as per the procedures detailed in AMS-I.D.

As per AMS I.D, the grid emission factor was calculated using the latest approved version of "Tool to calculate the emission factor for an electricity system" CDM methodology. The grid emission factor[1] calculated and published by the Sustainable Energy Authority in Sri Lanka for the year 2020 is used in the baseline emission calculation.

6.2. Project Emissions

Project emissions to be considered as per paragraph 39 & 40 of AMS I.D. Ver18.0 and discussion of their relevance for the project are presented in below.

Power plant is to be equipped with a diesel generator as a back-up power source. The emission due to operation of this back-up generator is estimated using the Methodological tool: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, version 03.0

[1]http://www.info.energy.gov.lk/

As per the tool, the CO_2 emissions from fossil fuel combustion should be calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y} \qquad \text{Equation (1)}$$

Where:

$PE_{FC,j,y}$	=	Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	=	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr)
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
i	=	Are the fuel types combusted in process *j* during the year *y*

Tool has also provided guidance on the calculation of CO2 emission coefficient $COEF$

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y} \qquad \text{Equation (4)}$$

Where:

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
$NCV_{i,y}$	=	Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	Is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)
i	=	Are the fuel types combusted in process *j* during the year *y*

Considering the frequency of power cuts and other system emergencies, annual diesel consumption was estimated for the on-site diesel generator as 400 litres. The resulting emission from the combustion of estimated diesel consumption is as follows.

Parameter	Value	Units	Source
Quantity of fuel combustion	400	L	Calculated
	0.4	m^3	
Mass unit/volume unit (Fuel Density)	840	Kg/ m^3	Ceylon Petroleum Corporation (CEYPETCO)
Net Calorific Value (NCV)	0.043	GJ/kg	IPCC Guideline, 2006
CO_2 emission factor	0.0741	tCO_2e/GJ	IPCC Guideline, 2006
Project emission from combustion of diesel	1.071	tCO_2e/year	Calculated
Rounded emission for conservativeness	2	tCO_2e/year	Calculated

As per the ex-ante estimate, the total annual emission from diesel generator is,

PEy = 2 tCO_2e/year

Overview of project emissions as per paragraph 39 & 40 of AMS I.D. Ver18.0 and their relevance for the project is mentioned below,

Para 39 & 40 of AMS I.D. Ver18.0: Project emissions include:	**Relevance for project activity**
For most renewable energy project activities, *PEy*=0. However, for the following categories of project activities, project emissions have to be considered following the procedure described in the most recent version of ACM0002. ○ Emissions related to the operation of geothermal power plants (e.g., non condensable gases, electricity/fossil fuel consumption); ○ Emissions from water reservoirs of hydropower plants.	No. As per the latest version of ACM0002, version 10, Consolidated baseline methodology for grid-connected electricity generation from renewable sources, the hydro power project activities that result in new reservoirs and hydro power project activities that result in the increase of existing reservoirs, project proponents requires to account for CH4 and CO2 emissions from the reservoir. The Maduru Oya Left Bank Canal Sluice Small Scale Hydropower Project located in the Maduru Oya Left Bank Main Canal Sluice has not changed or altered the capacity of the reservoir. In this backdrop, emission from water reservoir is not required to be accounted under the project emissions.
CO_2 emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of the tool to calculate project or leakage CO_2 emissions from fossil fuel combustion.	Yes. A back-up generator has been installed at the power plant to cater to essential power demands in the event of grid failure or sudden power outages. The emission arising from this source has been duly estimated and is reported as a project emission.

6.3. Leakage

As per the paragraph 42 of selected methodology, leakage emission is typically attributable to the operation and processes relating to the biomass project activities. The current project activity does not involve biomass plantation, processing and any treatment after harvesting, hence, no leakage emissions applicable to this project activity. Hence,

$$\mathbf{LE_y = 0}$$

6.4. Net GHG Emission Reductions and Removals

Emissions reductions are calculated as follows:

$$\mathbf{ERy = BEy – PEy - LEy}$$

Since LEy = 0;

$$\mathbf{ERy = BEy - PEy}$$

Summary of annual emission reduction calculation

Parameter	Value	Units	Source
Plant Capacity	5	MW	Proposed capacity
Plant Factor	36.52	%	Calculated
Average Energy Output	15,996	MWh/year	Calculated
Grid Emission Factor	0.7512	tCO_2e/MWh	Energy Balance-2020, SLSEA
Baseline Emission	12,016	tCO_2e/year	Calculated
Project Emission	2	tCO_2e/year	Calculated
Emission Reduction	12,014	tCO_2e/year	Calculated

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2021.03.01-28.02.2022	12,016	2	0	12,014
2022.03.01-28.02.2023	12,016	2	0	12,014
2023.03.01-29.02.2024	12,016	2	0	12,014
2024.03.01-28.02.2025	12,016	2	0	12,014
2025.03.01-28.02.2026	12,016	2	0	12,014

2026.03.01-28.02.2027	12,016	2	0	12,014
2027.03.01-29.02.2028	12,016	2	0	12,014
Total	**84,112**	**14**	**0**	**84,098**
Total number of crediting years	7 years			
Annual average over the crediting period	12,016	2	0	12,014

7. Monitoring

7.1. Data and Parameters Available at Validation

The responsibilities of various personnel in the organization in keeping records as follow,

Small hydropower operators monitor plant operation including energy generated and exported to the CEB grid by taking at least daily readings of generation levels and recording them on site. The monthly invoice sent to CEB by the small hydropower developers are cross checked by the CEB with the meter reading taken by the CEB staff and payment made accordingly. These data are also archived at Eagle Power (Pvt) Ltd. office in Panadura as well as the power station sites. The verifier will also be welcome to visit the power station sites and the office in Panadura to confirm the status of operations.

No leakage effects are applicable to the plant's operation as the equipment at the plant has not been moved from any other operational location.

Data / Parameter	**$EF_{CM,Grid,y}$**
Data unit	tCO_2e/MWh
Description	Combined margin CO_2 emission factor for grid connected power generation in year y
Source of data	Energy balance 2020 - Sri Lanka Sustainable Energy Authority
Value applied	0.7512
Justification of choice of data or description of	Methodological tool published by UNFCCC to calculate the emission factor for an electricity system

measurement methods and procedures applied	
Purpose of Data	Calculate the emission reduction
Comments	This factor will be applied to calculate actual emission reduction throughout the first crediting period.

Data / Parameter	$\rho_{i,y}$
Data unit	kg/m^3
Description	Weighted average density of generator fuel (Diesel)
Source of data	Values provided by national fuel supplier, Ceylon Petroleum Corporation (CEYPETCO)
Value applied	840 kg/m^3
Justification of choice of data or description of measurement methods and procedures applied	CEYPETCO conducts periodic testing of the specifications of Auto Diesel (A0013L99), which it supplies itself, and publishes the results on its official website for public access and reference. The laboratories owned and operated by CEYPETCO adhere to international best practice guidelines, standards, and protocols.
Purpose of Data	Calculate the mass of fuel consumed by the on-site diesel generator
Comments	This factor will be applied to calculate project emissions attributable to the project boundary

Data / Parameter	$NCV_{i,y}$
Data unit	GJ/kg
Description	Weighted average net calorific value of diesel
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
Value applied	0.043
Justification of choice of data or description of measurement methods and procedures applied	IPCC is an organization attached to UNFCCC publishing periodic reports on climate change and guidelines on national inventory development. As a technical body, IPPC reviews the latest global research findings of scientific communities and consolidate them into useable format through simplified reporting framework. The NCV values for fuel type are

	periodically published by IPPC for the use of reporting emissions from fossil fuels. Though these values are presented with an uncertainty range, they are recommended to be used in the emission offset calculation in the absence of local data. The locally published fuel calorific value is given by CEYPETCO on a gross basis. As this value needs to be converted into NCV using a conversion factor, the default value given in IPCC was used to minimize the uncertainty.
Purpose of Data	To estimate the energy content of fuel
Comments	This factor will be applied to calculate project emissions attributable to the project boundary

Data / Parameter	$EF_{CO2,i,y}$
Data unit	tCO_2e/GJ
Description	Weighted average CO_2 emission factor of fuel type (diesel)
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 Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value applied	0.0741
Justification of choice of data or description of measurement methods and procedures applied	As per the CDM methodological tool; *Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*, *version 03.3*, this value can be applied in the emission accounting of fossil fuel combustion.
Purpose of Data	To estimate the energy content of fuel
Comments	This factor will be applied to calculate project emissions attributable to the project boundary

7.2. Data and Parameters Monitored

Data / Parameter	$EG_{p.j.y}$
Data unit	MWh/year
Description	Quantity of net electricity exported to the CEB grid

Source of data	Monthly electricity export and import vouchers (bills) issued by CEB
Description of measurement methods and procedures to be applied	This parameter will be continuously monitored by project participants using an electronic energy meter supplied by CEB. The meter is a bidirectional meter and capable of measuring import and export data at the same time.
Frequency of monitoring/recording	*Daily and monthly*
Value applied	*15,996*
Monitoring equipment	*Energy meters* *Accuracy class of the meters- class 01* *From the developer side there will be two meters installed (of same accuracy class). One would be installed before the transformer and one after, so that the losses can be recorded. These meters will track the electricity generation. While CEB meters will track both import and export of electricity.*
QA/QC procedures to be applied	The meter will be properly calibrated and maintained in order to ensure accuracy. Testing/Calibration interval : Annually by CEB Cross checking of the data with the cheque received from CEB for import electricity to the grid
Purpose of data	*Calculate baseline emission*
Calculation method	The parameter is calculated by deducting the import energy from the export energy
Comments	Monitoring data will be archived for two years after the crediting period.

Data / Parameter	$FC_{i,j,y}$
Data unit	L/year
Description	Diesel burnt in the back-up generator
Source of data	Onsite measurements
Description of measurement methods and procedures to be applied	Fuel consumed by generator is measured by a ruler gauge fixed to the fuel tank. Power plant operators/ technicians are responsible for taking weekly measurements of the fuel consumption. A log book is maintained for recording
Frequency of monitoring/recording	*Measurements are taken on weekly basis*

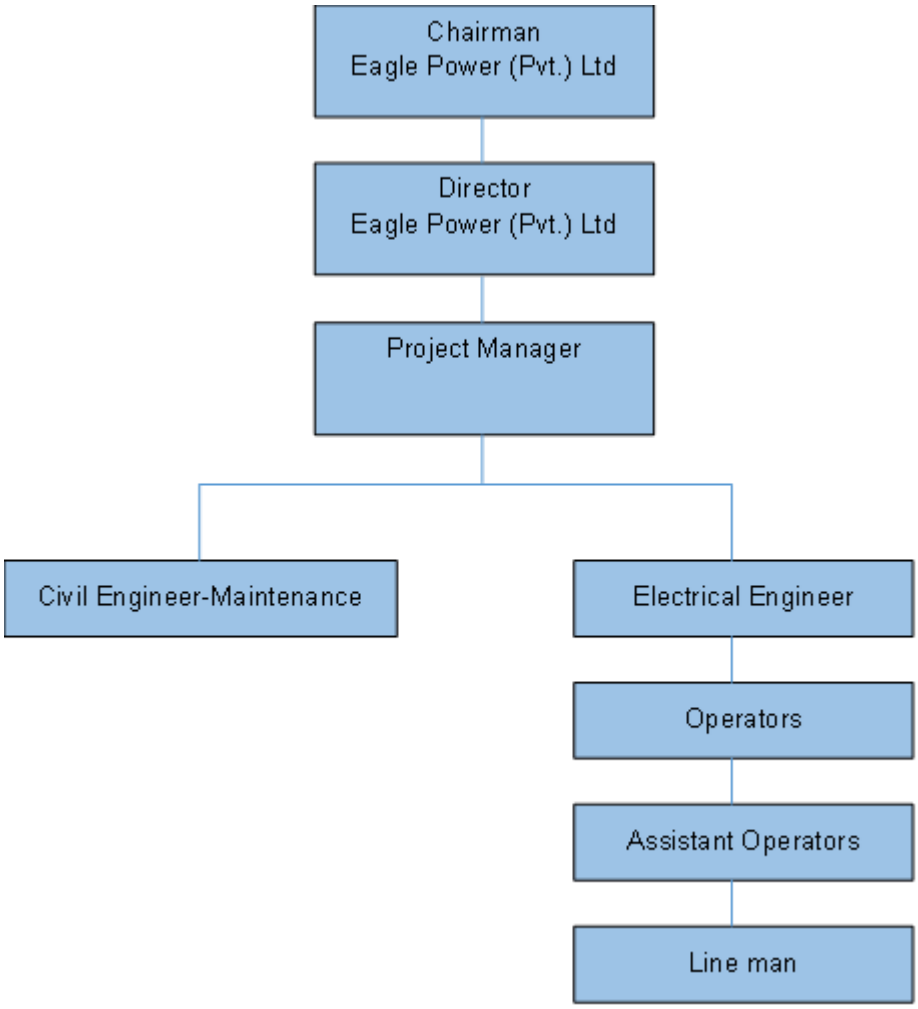
Value applied	400 L
Monitoring equipment	*Ruler gauge is used to measure fuel consumption*
QA/QC procedures to be applied	The fuel gauge will be properly calibrated and maintained in order to ensure accuracy. The fuel quantities consumed by generator is cross-checked with the purchased quantities in the monitoring period.
Purpose of data	*Calculate project emission for the operation of on-site diesel generator*
Calculation method	N/A
Comments	The recorded data will be reviewed and authorized by the project manager.

7.3. Monitoring Plan

The authority and responsibility for registration and overall monitoring would rest with the Director of the Eagle Power (Pvt) Ltd. Power plant operational staff team is headed by a Director from VS hydropower, works as consultant for the project, would continue their services, in the capacity of operational and maintenance supervisors after commissioning of the plant. VS hydropower consists an experienced team in various disciplines and would undertake periodic inspections to ensure the quality of the data collected by the team and initiate steps in case of any abnormal conditions.

The Plant Manager is assisted by operators and labourers. Power house operating staff shall operate the plant safely and shall keep records of plant operations. The responsibility of review, storage and archiving of information in good condition would lie with the Plant Manager. Also, it is the responsibility of the Plant Manager to make sure that routine maintenance of plant equipment is carried out in line with the instructions given in operations and maintenance manuals provided by the suppliers of respective equipment and recorded in given formats. Plant assistant operating staff is assisted by senior operators whose primary responsibility is to attend to day-to-day works.

Organization Structure



Parameters Requiring Monitoring

The monitoring of all parameters indicated in section 6.2 of the CMA would be monitored under this plan. Necessary documents required for verification of the data would be maintained for later archiving. Using the power exported to the grid, emission reductions would be calculated as illustrated in Section 5.4. Export & Import readings of main meter shall be taken on monthly basis at appointed day & hour (time) by authorized officer and would be reported to the Director.

Training of monitoring person

The project would employ qualified and experienced persons for plant operations. The project would maintain standard log sheets and formats to record the monitoring parameters. The plant staff would be given proper training to maintain the plant records. The Plant operator would be the designated person to verify, compile and archive all the monitored data. The parameters to be monitored during the crediting period would be provided in a tabular format to the designated person. The Plant operators would be provided with necessary training with respect to maintenance of the relevant monitoring

records to enable him/her to deal the monitoring independently. The training would be provided to the monitoring personnel for monitoring of the following parameters:

- Electricity Export
- Electricity Import
- Gross electricity generated
- Parameter of the plant, such as bearing temperature, electrical properties, etc
- Fault/Breakdown recording

Procedures for documentation and storage

Recorded data in monitoring sheets carried out by operators need to be checked by the Plant manager to identify any abnormalities. If any abnormality is noticed, Plant in Charge as well as operators need to take appropriate actions to rectify it. All the abnormalities need to be recorded in the log book maintained at the power house. In addition, regular maintenance work needs to be recorded in the given log books for each section. The day-to-day records are verified by Plant manager and internal monthly report would be prepared for review by the Director. Internal reports are the basic documents for the monitoring and storage of plant operational data. CEB will prepare monthly bills at the end of each month, based on export and import meter reading. CEB has the facility to monitor the readings through online metering system.

Procedures for Corrective actions

The parameters to be monitored during a crediting period would be compiled as internal report for every month of each crediting year and submitted to the Designated Director for review. The parameters include the Gross generation, Auxiliary consumption, Energy export and Import. The Designated Director would discuss and recommend necessary mechanism to improve the operational efficiency of the plant and directs the respective person to rectify the problem with the consultation from operator team.

QA & QC Procedures

The projects would employ such equipment or instruments that would measure, record, report, monitor and control of various key parameters of the plant. These monitoring and controls would be the part of the Control Systems of hydroelectric plant. For measuring the energy exported / imported main meter and a check meter as required would be in service. The check meter reading will be used to measure electricity export/import in case of failure of the main meter. The CEB officials will replace the main meter immediately on PP request. The meter would be calibrated and sealed at least once a year as per the CEB standard. Records of these test certificates would be maintained for

verification. Hence, high quality is ensured with the above parameters. Delivery records would be used and kept for checking the consistency of the recorded data.

Data Storage & Archiving

Export & Import readings from main meter will be collected under the supervision of the Plant Manager. Export and Import data would be recorded and stored in logs as well as in electronic form. The records are checked periodically by the Plant Manager.The period of storage of the monitored data will be 2 years after the end of crediting period or till the last issuance of CERs for the project activity whichever occurs later. The baseline emission factor would be adopted from the CEB published generation data for the latest available year for the CEB grid and the same would be used for the future projection and would be reviewed each year based on data published by the CEB. The monitored data would be presented to an independent verification agency or DOE to whom verification of emission reductions is assigned.

Maintenance of Equipment

All the equipment used in the project activity will undergo scheduled maintenance as specified in the operational manual of the equipment supplier. If meters are found to be defective, it would be tested and calibrated immediately. The defective meters will be replaced immediately by a new meter. The plant Manager is responsible to oversee the maintenance activity on periodic basis.

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