Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Broadlands Hydropower Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	06
Completion date of the PDD	28/01/2021
Project participants	Ceylon Electricity Board & Ecoeye Co. Ltd.
Host Party	Sri Lanka
Applied methodologies and standardized baselines	Methodology: ACM0002 – Consolidated baseline methodology for grid-connect electricity generation from renewable sources (Version 13.0.0)
Sectoral scopes	Sectoral Scope 01: Energy Industries (Renewable Sources)
Estimated amount of annual average GHG emission reductions	97903 tCO2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The main purpose of the project is to generate electricity from the renewable energy resources, secure energy security and be energy independent in some extent and to contribute sustainable development of the country.

The Broadlands Hydropower Project is located on the middle reach of the Keleni River, which originates in the Central Highlands in southern central Sri Lanka and flows into the Indian Ocean through the vicinity of Colombo City, and 95km east of Colombo. The project is located near the confluence of the Maskeliya Oya and the Kehelgamu Oya, which are the two main tributaries of upstream of the Kelani River.

The Kelani River Basin is entirely within a heavy-rain area. The annual precipitation upstream of the basin, where existing power stations are located, exceeds 4,000mm and that at the most upstream point exceeds 5,000mm. There are five power stations, with a total capacity of 335MW, in the river basin. The history of large-scale hydro power development in Sri Lanka begins with the construction of the Old Laxapana power station, which has been operating since 1950, in the basin, and four more power stations have been built since then. The Broadlands Hydropower Project is located downstream of these existing power stations, and might be the last promising hydro power project in the Kelani River Basin, for the limited remaining undeveloped hydro potential in Sri Lanka.

The Broadlands Hydropower Project is a run-of-river type. A maximum of 70m3/s water from a main dam, a concrete gravity dam 24m in height to be constructed just downstream of the outlet of the Polpitiya power station, is to be utilized. Up to 20m3/s water is to be diverted from the Kehelgamu Oya weir into the main dam. The power station plans to generate 137GWh electrical energy annually excluding 11 GWh generation reduction in the Polpitiya power station due to the increased tail water level. Although the average annual actual loss in Polpitiya power station is 11GWh but for the conservative approach, the loss is being calculated considering the possible maximum water level in Broadlands dam and generation loss is estimated to be 15.79GWh. Hence 15.79GWh has been deducted from the total annual electrical energy generation capacity (137GWh) of project activity to adjust the loss. Net energy generated to the grid is calculated by deducting sum of generation loss in Polpitiya power plant and auxiliary consumption of the project activity from the total energy generation from the project activity. Hence the net annual energy generation of the project activity is 120.749GWh (137 - 15.79 - 0.461). The detail calculation is explained as footnote of Table A.1. The power station turbines operate on a net head of 56.9m applied through a 3.4km long head race tunnel system.

The Main Dam and the other Weir would be located in the Ambagamuwa Korale division; Nuwaraeliya district of the Central Province and the powerhouse would be located in Yatiyantota division, Kegalle district in the Sabaragamuwa.

In this proposed project, a diversion weir will be erected in Kehelgamu Oya to divert its water to the Maskeliya Oya via an approximately 1km long tunnel. This weir is proposed to be located approximately a kilometer above the confluence of two streams. The other diversion, which is the main dam of the project, will be erected in Maskeliya Oya, and purpose of this dam is to divert water collected from both the streams to the proposed powerhouse. The dam would be located downstream of the said tunnel and this location will be about 0.5km downstream of the existing Polpitiya power station.

Water from the said main dam will be conveyed to the proposed 35MW powerhouse, first via a cut-and cover conduit and then through a tunnel. Combined length of the cut–and-cover conduit and the tunnel is approximately 3km. The tailrace of the powerhouse will join the Kattaran Oya at a location close to its confluence with Maskeliya Oya. This location is situated approximately 3.5km downstream of the confluence of Kehelgamu Oya and Maskeliya Oya.

Table A.1 Project information in brief

Catchment	
Main Dam	201 km^2
Kehelgamu Weir	176 km^2
Pondage (main dam)	
Total Storage Capacity	216000 m^3
Effective Storage Capacity	198000 m^3
Impounded Area	37700 m^2 (at El. 122 m)
Flood Water Level	122 m
Maximum Operation Water Level	121 m
Minimum Operation Water Level	111 m
Main Dam	
Type	Concrete Gravity
Height	24 m
Crest Length	114 m
Waterway	
Headrace Tunnel Length	3404.7 m
Penstock Length	243 m and 248.4 m
Powerhouse (Length, Width, Height)	32 m × 17 m × 33.2 m

Features of Hydropower Plant	
Discharge	69.46 m^3/s
Effective Head	56.9 m
Installed Capacity	35 MW (17.5 MW × 2)
Net Annual Energy generation	120.749 GWh (including reduction in Polpitiya PS)*

* Total electrical energy generation (137GWh) minus power generation loss in Polpitiya (15.79GWh) due to construction of Broadlands hydropower plant dam. So the actual energy generation from the project activity will be 121.21 GWh (137GWh – 15.79GWh). Net annual energy generation (120.749GWh) is the result of annual energy generation (121.21GWh) minus auxiliary energy consumption (0.38% of 121.21 GWh – data from CEB System control and operation, 2010).

Through supplying renewable electricity to the Ceylon Electricity Board (CEB) Grid, the project also contributes to sustainable development of the local community and the host country by means of:

1. Making greater use of renewable hydroelectric resources and diversifying sources of electricity generation of the grid. In the past the share of electricity generated from the hydropower was dominant but recent years the thermal power is dominant so the proposed project is among a very few remained potential projects that could provide renewable electricity to the national grid.
2. The proposed project will bring many environmental benefits compared with other fuel based power generation. It reduces the emission of greenhouse gas (GHG) compared to business-as – usual scenario. There will be no pollution emission such as SO2, NO and dust particles into the air and no discharge of pollution to soil and river.
3. Providing the employment opportunities to the local people during the project construction and operation phase. During the construction phase about 500 jobs will be created and priority will be given to local people depending on need of both skilled and unskilled manpower. About 50 employees are required during operational phase. It will also create business opportunity nearby project site.
4. Meeting increasing demand of electricity and improve investment atmosphere of local community.
5. Project will open access road, carry out certain stabilization construction and concreting works and slope treatment on sides of the road which will avoid the usual and frequent incur of mountain slides and improve the environmental conditions for local village households.

It will promote technology transfer to the country as electro-mechanical equipment will be imported from developed nations.

A.2. Location of project activity

>> Sri Lanka

Central Province and Sabaragamuwa Province

Ambagamuwa Korale division, Nuwaraeliya district, Central province and Yatiyantota division, Kegalle district, Sabaragamuwa Province.

This project is situated in the margins of the central highlands of Sri Lanka in the Kelani river basin about 95 km away from Colombo. The area is widely underlain by pre-cambrian geneiss. The

tributaries of the Kelani River, the Maskeliya Oya and Kehelgamu Oya, originate from the southwest slope of Mt. Kerigalpota (2,395m) and flow northwestward.

The main dam and the other weir would be located in the Ambagamuwa Korale division, Nuwaraeliya district of the Central Province and the powerhouse would be located in Yatiyantota division, Kegalle district in the Sabaragamuwa Province. Following figure shows the project location.

The co-ordinates of the site are;

Main Dam: 6^0 58' 44.78"N and 80^0 27' 14.80"E

Power Plant: 6^0 59' 2.38''N and 80^0 25' 27.46''E

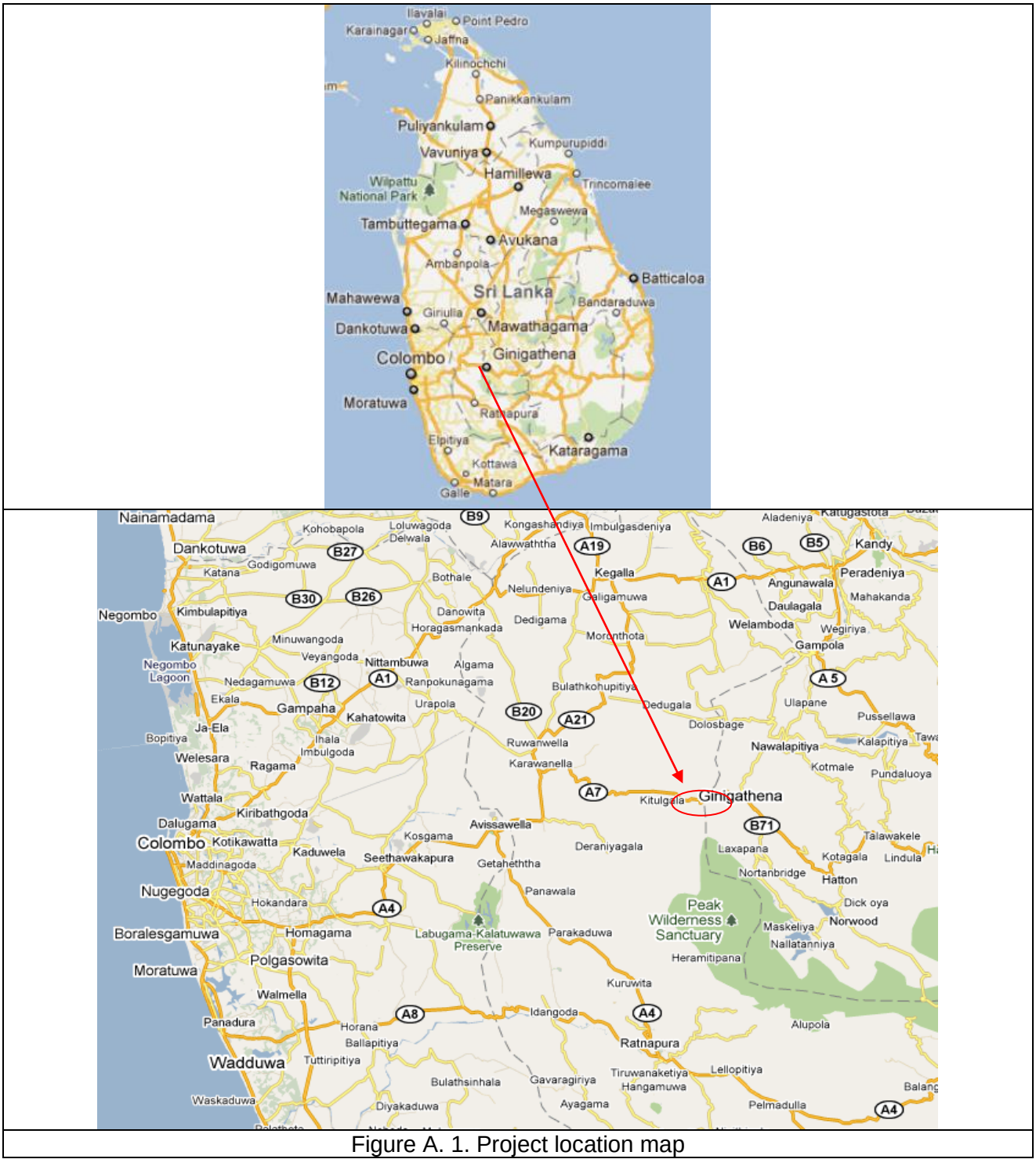

Figure A. 1. Project location map

A.3. Technologies/measures

>> The proposed project is a run-of-river type hydropower plant. A maximum of 70m3/s water from a main dam, a concrete gravity dam 24m in height to be constructed just downstream of the outlet of the Polpitiya power station, is to be utilized. Up to 20m3/s water is to be diverted from the Kehelgamu Oya weir into the main dam. The power station generates 137GWh electricity annually excluding reduced energy at the Polpitiya power station using a 56.9m effective head obtained by a 3.4km length pressure headrace.

The electricity generated from Broadlands hydropower project will be connected to national grid through 132 kV and 33 kV (for import) transmission line from Broadlands power plant switch yard to Polpitiya power plant switch yard.

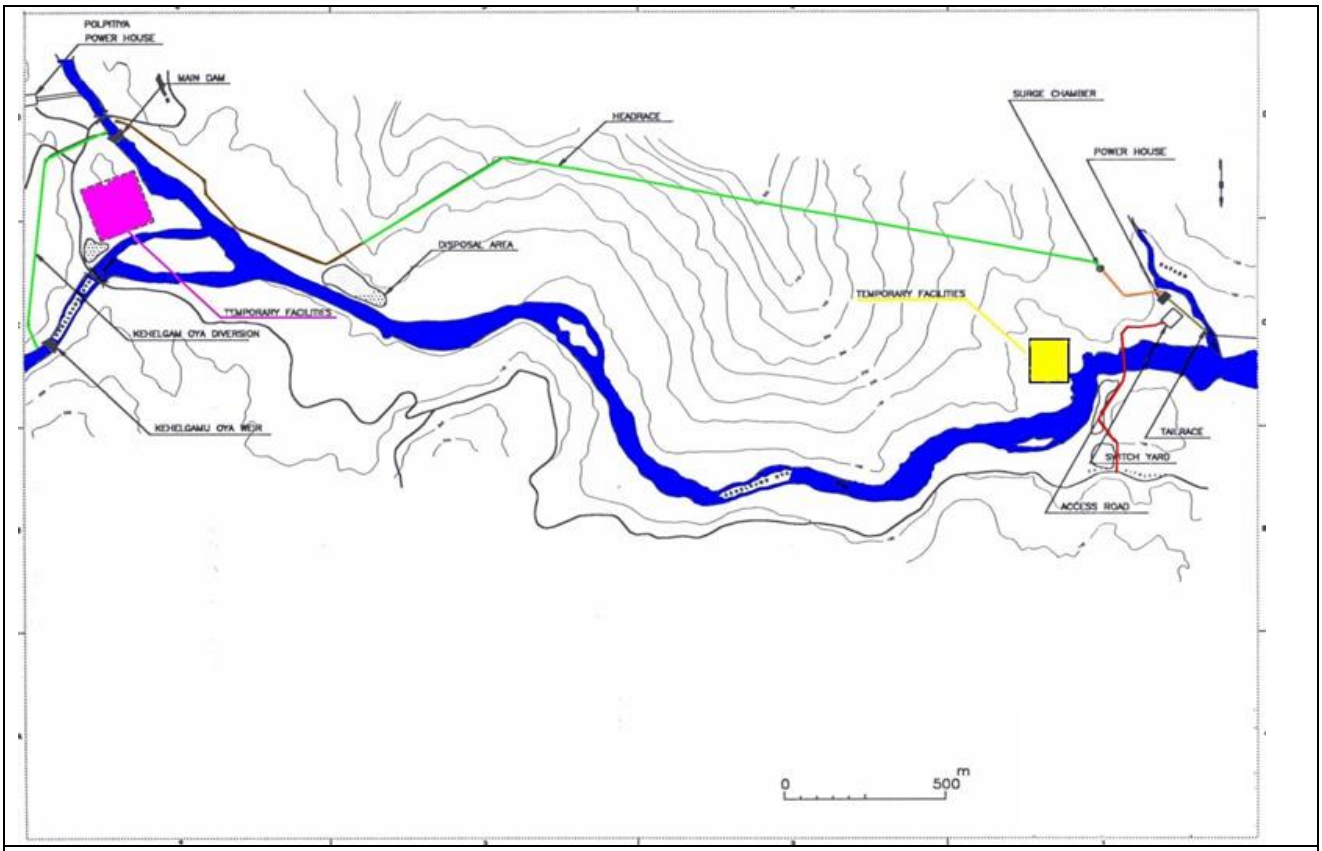

Figure. A.2. A schematic representation of the proposed project activity

The main technology of the project is detailed in the Table A.2. As a source of renewable energy hydropower is considered to be relatively environmentally safe.

Table A. 2. The main technology used in the project

Equipment	Items	Specification
Turbine	Type	Francis
	No. of Unites	2
	Rated effective Head	56.9m

	Rated Discharge (per unit)	34.731 m^3/sec
	Rated Speed	300rpm
	Runway Speed	586 rpm
Generator	Type	3-phase synchronous
	No. of units	2
	Frequency	50 Hz
	Synchronous speed	300 rpm
	Runway Speed	591.2 rpm
Main Transformer	Type	Y – Δ, outdoor
	No. of units	2
	Voltage	132 / 11 kV

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Sri Lanka (host country)	Ceylon Electricity Board	No
Republic of Korea	Ecoeye Co. Ltd.	No

A.5. Public funding of project activity

>> No public funding from Annex I party is involved in this project activity.

A.6. History of project activity

>> The project activity is a registered CDM Project (reference number 9252), registration date 27 December 2012 and applied for change in Crediting Start Date in 2020. Therefore, project participant-

1. Confirms that:

(a) The project activity is registered as a CDM project activity but not included as a component project activity (CPA) in a registered CDM programme of activities (PoA);

(b) The project activity is not a project activity that has been deregistered.

2. Declares that:

(a) The CDM project activity was not a CPA that has been excluded from a registered CDM PoA;

(b) A registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) does not exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

>> Not applicable

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>> Version 13.0.0 of the approved methodology ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources” was adopted.

(Link to the methodology

https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQC0PIWPGWDN8ED5PG)

Other methodological tools applied along with methodology are as follow;

- “Tool for the Demonstration and Assessment of additionality” Ver. 06.1.0
- “Combined tool to identify the baseline scenario and demonstrate additionality” Ver. 04.0.0
- “Tool to calculate the emission factor for an electricity system” Ver. 07.0.0

For more information please refer to the link below:

https://cdm.unfccc.int/Reference/tools/index.html

B.2. Applicability of methodologies and standardized baselines

>> The approved consolidated baseline methodology ACM0002/Version 13.0.0 is applied to determine the baseline of the project. It is chosen and applicable to the project due to the following reasons:

① The project activity is the installation of a new hydropower plant (run-of-river) and supply generated electricity to Sri Lankan national grid;

② The project is a new hydropower plant with a reservoir of the power density of 928.38 W/m2, which is greater than 4 W/m2.

③ The project is not an activity that involves switching from fossil fuels to renewable energy at the site of the project activity.

④ The proposed Broadlands Hydropower Project will connect to national grid (Ceylon Electricity Board). The geographic and boundaries for the connected Ceylon Electricity Grid can be clearly identified and information on the characteristics of the CEB Grid is publically available.

B.3. Project boundary, sources and greenhouse gases (GHGs)

>> According to the definition of the project boundary stipulated by the ACM0002 (Version 13.0.0), the spatial extent of the project boundary includes the project power plant and all power plants physically connected to the electricity system where the project is connected to. According to the selected methodology ACM0002 (Version 13.0.0), the relevant electricity system of the project shall be referred to the tool to calculate the emission factor for an electricity system (Version 07.0.0).

According to the tool to calculate the emission factor for an electricity system (Version 07.0.0), the project electricity system is the National Grid Ceylon Electricity Board. Therefore, the project

boundary of the project includes the project power plant and all power plants physically connected to the CEB grid.

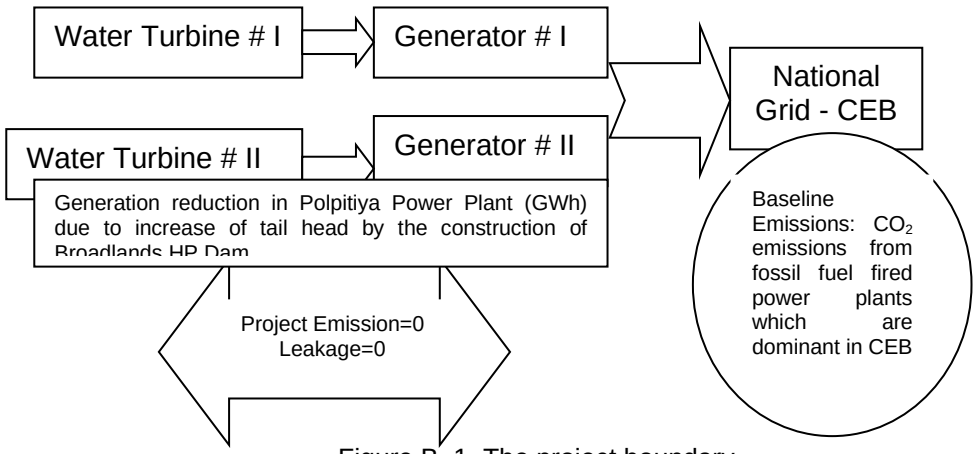

Figure B. 1. The project boundary

Source		GHG	Included?	Justification/Explanation
Baseline scenario	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project scenario	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Power generation from renewable energy sources does not emit CO_2
		CH_4	No	It's not necessary to include as the power density is > 10 W/m^2
		N_2O	No	Power generation from renewable energy sources does not emit N_2O

B.4. Establishment and description of baseline scenario

>> Since the project is the installation of a new grid-connected renewable power plant, the baseline scenario is the following:

Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the Emission Factor for and Electricity System".

The state-owned company Ceylon Electricity Board (CEB) dominates power generation, transmission, and distribution in Sri Lanka. One of the key assumptions made in determining the baseline is to treat the whole grid system as one entity. In Sri Lanka the grid system is not divided into provincial sub-groups.

B.5. Demonstration of additionality

>> As the proposed project activity is not financially feasible without CDM revenue, the project owner announced international bidding for CDM consultancy and based on the application received the most financially attractive and experienced consultancy was selected on June 20, 2011. Ecoeye Co., Ltd., Republic of Korea won the bidding for CDM development and registration and signed the agreement with Ceylon Electricity Board (CEB) on August 18, 2011.

The project owner has been very familiar with the potential of CDM to support the project activity before the earliest date of the project initiation. In accordance to the requirement of the ACM0002 Version 13.0.0, the additionality of the proposed project activity is demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" (version 06.1.0) and "Combined tool to identify the baseline scenario and demonstrate additionality" (version 04.0.0) approved by CDM EB, as shown in the following steps:

Step 1. Identify realistic and credible alternative baseline scenarios for power generation

Step 1a. Define alternatives scenarios to the proposed CDM project activity; alternatives can be treated as the baseline scenario or part of baseline scenario:

Possible alternatives to the proposed project activity with equivalent output include:

P1: The proposed project activity undertaken without being registered as a CDM project activity;
P2: The continuation of the current situation, i.e. to use all power generation equipment that already in use prior to the implementation of the project activity and undertaking business as usual maintenance. The additional power generated under the project would be generated in existing and new gird connected power plants in the electricity system; and
P3: All other plausible and credible alternatives to the project activity that provide an increase in the power generation at the site, which are technically feasible to implement. This includes, inter alia, different levels of replacement and/or retrofit at the power plant/unit(s).

An analysis of the three options identified above to identify the most realistic and credible alternatives are presented below:

Alternative (P1) not a credible not realistic alternative as, according to the investment analysis presented in section b. 5 below, without the assistance of the CDM, the project is not a financially attractive for investment. The project owner became able to find the most cost effective construction company through international bidding which is more than 20% cheaper than its own

engineering estimation[1]. Even in such lower cost option the project is found not to be economically beneficial.

Alternative (P2) is the continuation of current situation means equivalent electricity provided by the CEB national grid which is the most credible and realistic scenario (hence it is the baseline scenario).

Alternative (P3) cannot be a competitive option over the proposed hydropower as the project entity is a governmental agency and pays high concern to the environment by leading on development of environmentally compatible and efficient energy solution. The thermal power generated in Sri Lanka is mainly fuelled by diesel and there is the high fluctuation in oil price in international market. To achieve the energy security with more consideration, CEB aims to utilize national resources more effectively[2].

Renewable power generation option is not feasible at the project area due to lack of proven reserves there.

Solar PV, wind, biomass, and geothermal energy sources are the possible grid-connected renewable energy technologies that could be applied in CEB national grid. The government endeavours to reach a minimum level of 10% of the gird electricity using non conventional renewable energy by 2015 and at the same time the cost of renewable energy generation is high which is being unable to attract private sector without governmental subsidy or cost based feed in tariff which ultimately increases the electricity cost to the consumers. This project site lies in the mountainous area, there is no proven potential reserves for solar and wind energy resources. It is impossible to install the equivalent solar power plant in this area mainly because of geographical structure specially slope terrain, availability of appropriate and sufficient land. The area is covered with dense forest as well as tea farms so it requires clearing huge area to install equivalent capacity solar power plant in the area which will have huge environment, social and economic impact. Geothermal energy has not still been considered for potential renewable in Sri Lanka[3]. Biomass project of equivalent capacity in the project site is impossible due to the lack of sustainable raw material supply.

Outcome of Step 1a: Alternative P2 is found to be only one alternative to the proposed CDM project activity.

Step 1b: Consistency with mandatory applicable Laws and Regulations

[1] Engineering estimation provided by CEB
[2] National Energy Policy and Strategies of Sri Lanka, Ministry of Power and Energy, Government of Sri Lanka, 2006
[3] http://www.energy.gov.lk/sub_pgs/energy_renewable_intro_resources.html

The only identified alternative to the project is alternative (P2) and this is in compliance with all Sri Lankan legal and regulatory requirements. Large scale hydropower projects are already operational in Sri Lanka and for the construction of such project, it needs to carry out environmental impact assessment. The project has carried out environment impact assessment which is already approved by concerning department.

Step 2: Barrier analysis

Step 2a: Identify barriers that would prevent the implementation of alternative scenarios

Three types of barriers; investment barriers, technological barriers and other barriers have been considered here following the combined tool to identify the baseline scenario and demonstrate additionality, Ver. 03.0.1.

a) Investment Barriers

The proposed project does not have any investment barriers that would prevent the implementation of the alternative scenarios other than the project risks, and low internal rate of return as analyzed in investment analysis section (Step 3).

b) Technological Barriers

The power generation from hydropower is well developed technology and commonly used in Sri Lanka. There are already several hydropower projects and mostly are constructed more than 20 years ago with the official development assistance of developed countries. The technology was imported from other developed countries and hydropower has played a vital role for the sustainable development of the country. There are not any technological barriers that would prevent the implementation of the identified alternative scenario.

c) Other barriers

There are no other barriers that would prevent the implementation of the alternative scenarios.

Step 2b. Eliminate alternatives scenarios which prevented by the identified barriers.

As no barriers that would prevent the implementation of the alternative scenarios were found in step 2a, this step is not relevant. The only major problem that the project has been facing for several years is unavailability of fund to implement the project. CDM revenue will play the significant role to minimize the loss of the project. The economic aspects of the project is analysed in step 3 below.

Step 3: Investment Analysis

Step 3a: Determine appropriate analysis method

This is a large scale project activity. Hence, additionality of the project has to be demonstrated as per the Additionality Tool, Version 06.1.0. The Tool for the Demonstration and Assessment of Additionality provides three methods of analysis: simple cost analysis (option I), investment comparison analysis (option II) and benchmark analysis (option III).

As only one option i.e. P2 remains after Step 1 and Step 2, according to Methodology ACM0002 (Version 13.0.0), benchmark analysis, as per Step 2b of the "Tool for the demonstration and assessment of additionality" is applied.

Step 3b: Apply Benchmark Analysis

Additionality Tool, version 06.1.0 stipulates that the project developer should identify the financial / economic indicator, such as IRR, most suitable for the project type and decision context. As prescribed by the additionality Tool itself, the project developer has chosen project IRR to demonstrate the additionality.

The project IRR needs to be compared with a benchmark to prove the financial unattractiveness of the project. Based on Additionality Tool and Guidance on the assessment of investment analysis, issued by EB 41, the selected benchmark should satisfy three conditions: it should be government/official approved; it should be used for investment decisions; and it should be publically available data source so that DOE can validate. Project developer was considering about the project implementation since its feasibility study completed in earlier 2004. The total investment required for the project implementation was out of the range of developer estimation and financial capacity. Because of this fact project developer could not make investment decision until they find and sign a contract with appropriate construction company. To find an appropriate contactor that could complete the construction work under CEB estimated cost, international bidding was announced. Through international bidding the project owner became able to find a contractor under its estimation and decided to implement the project. At the same day of contract signing, project owner finalized their decision to implement the project. Hence investment decision date according to the project owner decision is same as contract signing date i.e. 2010/10/20. Broadlands Hydropower Project announced it with a notice in 2010/10/18.

Guidance on the Assessment of Investment Analysis states that, "in cases where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR". There is not any standard benchmark IRR for the investment analysis of the investment in hydropower sector. In case of the lack of standard benchmark IRR,

the project developer has selected the commercial lending rate offered by commercial banks in Sri Lanka at the time of decision making. Average Weighted Prime Lending Rate (AWPR) of three years (from Oct 2007 to Sept 2010) has been chosen to compare with the project IRR. Three years average has been chosen as the project developer was actively involved to find the appropriate investment options and making final decision of the investment. The weighted average prime lending rate over the period preceding the decision was used with the legally mandated mark up to arrive at the commercial lending rate of 15.58%.

- The lending rate of commercial banks is based on the Central Bank of Sri Lanka and hence it is official rate;
- The benchmark is used by commercial banks to take a financing decision
- The benchmark is publically available data source and verifiable by DOE.

The benchmark of 15.58% chosen, and hence it fulfils all the required criteria laid down by the Additionality Tool.

The project developer has the return obtained from the project activity with this benchmark to prove the project is financially unattractive.

Step 3c. Calculation and comparison of financial indicators

To compare the economic profitability the project, IRR calculation was done. As there is no equity investment, project IRR is calculated based and 100 % of the project investment is from loan. The following input parameters (Table B.2) were considered in making the projected income statement and IRR calculation.

Table B. 2: Input parameter

Parameter and Unit	Value	Basis
Installed Capacity (MW)	35	Feasibility study
Total annual generation (MWh)	137,000	Feasibility study report
Mean annual generation loss in Polpitiya power station (GWh)	11	Feasibility study report
Generation loss in Polpitiya power station (conservative approach) (GWh)	15.79	Computed based on feasibility study report at maximum water level in Broadlands dam
Annual net power supplied to the grid (MWh)	120749	Computed from feasibility study data*
Aux. consumption (% of generation)	0.38	CEB System Control and Operations data (2010)
Area of the reservoir (m2)	38,000	Data from CEB
Total Investment (Million US$)	82	Loan agreement

O & M cost (Million US$)	0.82	1% of total investment (feasibility study)
Ratio of foreign loan and local loan	85:15	Loan document
Grace period foreign & local loan (Year)	5 & 3	Loan document
Loan disbursement instalments (%)	15, 25, 35,25	Computed from loan document and construction plan
Discount rate (%)	15.58	Calculation from data published by Central Bank of Sri Lanka
Tariff (US$/kWh)	0.0993	IPP average tariff of 2010 (~LKR 11.30)
CER price (USD/CER)	19.09	Blue Next (average price of Oct. 2010)

* Annual energy generation (137GWh) minus generation loss in Polpitiya power station (15.79GWh) minus auxiliary consumption of hydropower in Sri Lanka in 2010 (0.38% of the total generation)

Economic analysis is done based on the available data in feasibility report, recent changes and data received from other verifiable sources. While calculating the IRR revenue generated by selling the electricity is considered as cash inflow. Total amount of electricity supplied to the gird annually is 120.21GWh and regarding electricity tariff, CEB as a public entity does not have specific tariff for the electricity generated from Broadlands Hydropower project so the average tariff for independent power producers for 2010 is considered for this project as well which is 0.0993 US$/kWh. In fact, the price that consumers pay to CEB is much less than considered tariff. If the average electricity price is considered as tariff for economic analysis, the IRR will be still lower compared to IRR received here.

Following the guidelines on assessment of investment analysis, the cost of financial expenditures (i.e loan repayment and interest) has not been included in the calculation of project IRR. According to the guideline, IRR is generally calculated considering the project minimum of 10 years to maximum of 20 years. In case of Broadlands hydropower project, the project life is estimated for 50 years and the replacement will be done in 35, 36 and 37 years. So the cost incurred for replacement is included in cash outflow. If the project life is considered for 20 years, the economic viability of the project is found to be still lower than considering 50 years.

Another important aspect that is considered during IRR calculation is O&M cost. According to the feasibility study report prepared in 2004, the O&M cost was consider as 1% of the financial cost. According to this consideration, it was 1.124 million US$. In this calculation O&M cost is considered as 1% of total investment which is 0.82 million US$. Normally the cost of products and services increase each year so it should be more than that of the cost calculated in 2004 but the project owner through international bidding became able to find the contractor in cheaper price

than their own engineering estimation. Hence they became able to reduce the investment cost. Although reduced initial investment does not have much effect on O&M cost, O&M cost is considered lower following the prevailing norms. O&M cost is also required during the construction period but it is considered after the operation starts. If it is considered it from the first year of the construction, the IRR will be still lower.

Based on the above, the project IRR works out to 11.62% as against the benchmark return of 15.58%. Table B. 3 presents the result of the IRR analysis in comparison with the benchmark identified in step 2b.

Table B. 3: Comparison of IRR with the benchmark rate of return

IRR	Project IRR	Benchmark
Value	11.62 %	15.58%

The IRR estimate is quite simple and conservative in the sense that the project revenue does not include any tax and if it is considered, the IRR will still come down.

Sri Lanka has adapted Non Conventional Renewable Energy (NCRE) tariff under which renewable power plants up to 10 MW either can get three-tier tariff or a flat tariff. Standardized Power Purchase Agreement (SPPA) is made between CEB and developers and developers can choose any of among the aforementioned two options. Large hydropower does not receive any economic benefits from the NCRE. The policy and law considered for establishing baseline and demonstrating additionality are listed below;

Policy/ Regulation/ Law	Policy/ Regulation/ Law Major Point
Non Conventional Renewable Energy Tariff, Public Utility Commission of Sri Lanka	It is cost-based and technology based and large hydropower cannot get any cost benefit from it[4]
National Energy Policy and Strategies of Sri Lanka, Ministry of power and energy, Govt. of Sri Lanka (Oct. 2006)	Large hydropower development is limited due to lower economic viability and it has mentioned that renewable energy will be promoted considering CDM benefit and other means. New and renewable energy target for 2015 is 10% of total generation.
The Development Policy Framework Government of Sri Lanka (Nov, 2010)	Target 20% electricity generation from NRE by 2020 with the target of 10% met by the end of 2016[5]

[4] http://www.ceb.lk/download/db/ncre_tariff.pdf

[5] http://www.treasury.gov.lk/publications/mahindaChintanaVision-2010full-eng.pdf

Long-term generation expansion plan, 2009-2022, (Dec. 2008)	There needs to install large scale coal-fired, fuel oil- CEB fired and diesel-fired conventional plants to meet energy demand of Sri Lanka. Broadlands hydropower is considered among very few candidate hydroelectric plants for this period.

Step 3d: Sensitivity Analysis

Sensitivity analysis is conducted to check the robustness of above conclusion. It checks whether under reasonable variations in the critical assumptions, the result of analysis remain sufficient. Guidance on the Assessment of Investment Analysis defines critical assumptions as those, which constitute more than 20% of total costs or total project revenue and reasonable variation has been defined as a range of +10% and -10% (item No 16 and 17 of the Guidance). Three variations are considered in the sensitivity analysis;

Project Investment
O & M Expense
Net Generation
Tariff

Table B. 4: Sensitivity Analysis

Details	-10%	Base Case	+10%
Total Investment	12.76%	11.62%	10.66%
O & M Expenses	11.70%	11.62%	11.54%
Net generation	10.47%	11.62%	12.73%
Tariff	10.47%	11.62%	12.73%
Benchmark	15.58%		

From the above computation it could be seen that even under the most optimistic conditions, the project IRR will not cross the benchmark. It proves that the project is financially unattractive.

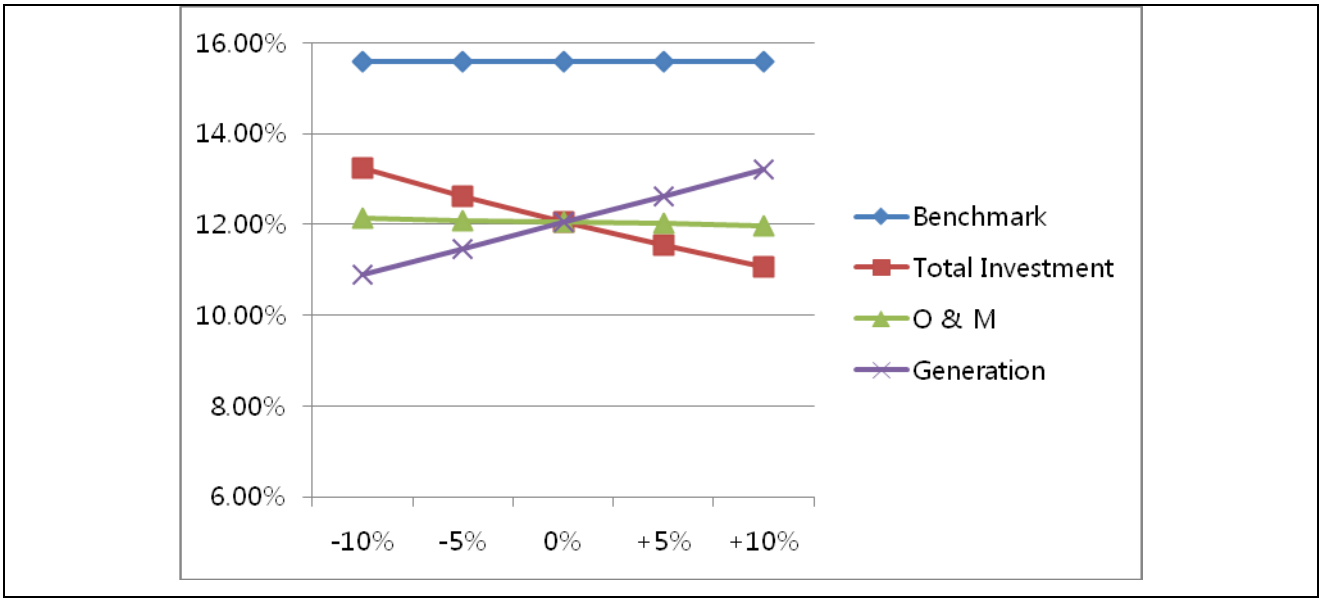

Figure B. 2: Sensitivity analysis curve

Project cost is an important parameter and it usually goes on increasing than the expected one due to increase in cost of construction materials, labour cost, social costs etc. Considering the values of other variables remains the same, and decreasing the total project investment (construction cost) by 10%, even in this condition the IRR is lower than the benchmark. O & M cost is not a major assumption and the project is very insensitive to the change in the O & M cost which could be seen from the table B. 4 and figure B. 2 above.

Increment in generation amount is also highly unlikely as it depends on the climatic condition and the installed capacity. As the run of river hydropower depends on the flow rate of the river which usually varies depending on seasons; electromechanical equipment and its capacity. Discharge is determined by the historical data of flow rate. 10% increment of amount of power generation cannot be usually expected and even if it becomes possible, the IRR generated from the project will goes up just up to 12.73% which is still less than the benchmark discount rate. Increment of tariff also produces the same result that of with increment of net generation. Though increment of tariff is more likely than increment of net generation but the IRR generated in +10% fluctuation is still less the benchmark IRR.

In above condition, the project is not attractive to the investors so it shows the greater need for financial assistance from the CDM. The project therefore is not a business-as-usual and hence additional.

Step 4: Common Practice Analysis

Step 4a. Analyze other activities similar to the proposed project activity

According to the “Guidelines of Common Practice” (Ver. 02.0), the applicable geographical area for common practice is geographical boundary of Sri Lanka. Technologies with comparable output are considered for the analytical purpose.

Large hydropower projects in Sri Lanka are built and operated by the government. Economically attractive hydropower projects were already constructed. Kukule was the last hydropower plant that was commissioned in 2003. Almost all hydropower potential were harnessed between fifties to eighties. With the increasing demand for energy to provide for the country's economic and social development, total primary energy demand is expected to increase to about 15,000 kTOE by the year 2020 at an average annual growth rate of about 3%[6].

As the capacity of the project is 35 MW the applicable output range for common practice analysis is 17.5 MW to 52.5 MW. The following are the list projects that are operational before the start date of the project and within the applicable range.

Table B.5. List of power plant in available output range

Power Station	Installed Capacity	Total Capacity /Fuel Type	Commission Date	Remarks
Old Laxapana - Stage I & II	3×8.33+2×12.5	50 / Hydro	Dec, 1950 & Dec, 1958	Not comparable*
Wimalasurendra	2×25	50 / Hydro	January, 1965	Not comparable*
Ukawela	2×20	40 / Hydro	Unit 1 July, 1976 Unit 2 - Aug, 1976	
Bowatenna	1×40	40 / Hydro	Jun, 1981	Not comparable **
Rantambe	2×25	50 / Hydro	Jan, 1990	Not comparable **
Asia Power Ltd	51	51 / HFO	Jun, 1998	
Lakdanavi Ltd	23	23 / LFO	Nov, 1997	
ACE Power Horana	20	20 / HFO	Dec, 2002	
ACE Power Matara	20	20 / HFO	Mar, 2002	

** Investment climate is different as projects loan were signed more than 40 years ago as well as project were also commenced 40 years ago.*

*** Investment climate is different as the projects were constructed using ODA loan. Bowatenna received ODA loan from Arabian and Rantambe received ODA loan from German government.*

Hence, the projects in applicable output range with comparable investment climates are as follow;

Nall = 5 & Ndiff = 4

F = 1-Ndiff/Nall = 0.2

[6] http://www.energy.gov.lk/pdf/gazette/Gazette_1553_10_English.pdf

Factor F would be even less if Ukawela hydropower plant is also excluded from the comparable list due to long time difference with commencement date of proposed power plant. Calculation shows that it is not more than 0.2.

Similarly,

Nall - Ndiff = 1

As the guidance pointed out that “the proposed project activity is a common practice within a sector in the applicable geographical area if the factor F is greater than 0.2 and Nall - Ndiff is greater than 3” Here both criteria do not match and hence the proposed project is not a common practice in Sri Lanka.

Paragraph (44) of the “Tool for the demonstration and assessment of additionality” also describes that the projects are considered as similar if they are in the same country/ region and/ or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. According to this clause one of the most important criteria is investment climate and fund which has been considered for common practice analysis done above.

Electricity and petroleum sub-sectors are likely to record higher annual growth rates of about 7-8% and at the same time hydropower and biomass based energy supply are expected to increase just marginally[7]. This is mainly due to limitations in further hydropower development owing to lower economic viability of exploiting the remaining large hydropower sites and limited use of biomass with gradually increasing standard of living of the population.

Of the seven registered CDM projects in Sri Lanka five are hydropower and all of them are small scale hydropower projects. There are not any hydropower plants in pipeline, comparable with Broadlands hydropower project, which are considering construction in near future. It is due to the economic unattractiveness of the hydropower plants in Sri Lanka. Government of Sri Lanka has given high importance to this project as this will be the first of its kind to be constructed by considering the CDM benefit.

According to the “Tool for the demonstration and assessment of additionality” (Version 06.1.0) the registered project activities and project activities which have been published on the UNFCCC website are not necessary to be compared with this project activity. The Ceylon Electricity Board considers all hydro power projects above 10 MW as Conventional Hydro Power (large hydro). But ACM0002 methodology is not applicable to the hydropower project with capacity less than 15 MW.

Step 4b: Discuss any similar options that are occurring:

[7] http://www.sari-energy.org/PageFiles/Countries/Sri_Lanka_Energy_detail.asp

All large hydropower plants in Sri Lanka are built and operated by government. Since 2003, any new large hydropower plant has not been constructed in Sri Lanka except Upper Kotmale (commenced in July 14, 2012) which was constructed under Overseas Development Assistance (ODA) of Japan[8]. Sri Lankan government has a target to generate 10% of electrical energy supplied to the grid to be from nonconventional renewable energy (NRE) by 2015 and it has given high priority on CDM registration so that it can increase the financial viability of the projects. Early days of grid electricity generation considered hydro as the major component in electricity generation, accounting for more than 90% of the total generation. Recently, this component has been reduced to 35% mainly due to the exponential load growth, which cannot be met by this limited resource[9]. The Electricity Act of 2009 and the development of the sector report published in June 03, 2009, even explain that hydro power sector covered about 95% of electricity generation in 1995. Another important aspect to be considered is that large hydropower in Sri Lanka is being owned by state owned agency, Ceylon Electricity Board. While considering the above fact and calculation of F factor, it is obvious that large hydropower in recent years is not a common practice in Sri Lanka. Due to economically unattractiveness of the remaining possible projects, neither the government itself nor the banks were ready to finance for the hydropower projects. As a result of it none of the large hydropower plant similar to the proposed project was constructed after 2003.

Usually the people living in the project vicinity and other stakeholders raise several kinds of demands that are mainly related to the social welfare for the community. If the project itself is not economically attractive and do not have sufficient fund to fulfill the demand of local people, it will bring considerable hindrance and delay for the implementation of the project. CDM benefits from this project could be utilized for the socially development and make the project economically attractive. Ceylon Electricity Board is considering CDM benefit for this project[10]. Thermal power generation become comparatively cheaper than hydropower so both CEB and private investors became more attractive towards thermal power generation. Under the policy to promote the renewable energy and increase its share in total national energy mix, government has given more emphasis toward remaining possible large hydropower by considering CDM revenue. Broadlands hydropower project also tried to receive investment since 2003 but it could not be realized due to huge investment cost and less financial attractiveness. Hence the CEB from its initial stage of feasibility study considered CDM as an important aspect to support the financial viability of the project.

The dominance of hydropower has reduced significantly in a decade, from 95% in mid 90s to about 43% in 2010 (including other renewable energy). Some small hydropower projects in Sri Lanka have been registered as CDM project in UNFCCC. It proves that large hydropower plants are not

[8] http://www.ukhp.lk/funding.html
[9] Electricity Generation in Sri Lanka from Renewable Energy: Future Direction, M.M.C. Ferdinando and R.J. Gunawardana.
[10] http://www.naturesolutions.org/pdf/Sri%20Lankan%20potential%20in%20CDM.pdf

common practice in Sri Lanka in these days because of change in investment climate. Very limited remaining potential projects and the higher investment costs are the major reason that hinders the investment in the sector. Hence the government is highly concerned on registration of CDM and receiving CERs to support the huge investment cost. Considering the above facts, it is clear that Broadlands hydropower will be the first of its kind to be registered as CDM project and that may promote similar kind of hydropower plants in Sri Lanka.

Prior CDM consideration

The propose project considered the CDM benefits as early as the preparation of the project itself. In the feasibility report of Broadlands Hydropower project prepared in 2004, the importance of the CDM benefits to the construction of project was addressed.

As per the guidance of EB Meeting Report 49 Annex 22, the project proponent should notify the UNFCCC of the intent to implement the project as a CDM project activity within six months and this notification was accordingly acknowledged as received on 2010/03/31.

Major events concerning to the project are as follow;

Date	Events
15/12/1986	Pre feasibility study financed by the CEB and carried out by Central Engineering Consultancy Bureau (CECB)
16/02/2004	Feasibility study carried out by JICA
05/02/2010	EIA approval by Central Environmental Authority
31/03/2010	Notification to UNFCCC secretariat and Sri Lanka DNA
17/06/2010	Announcement for CDM consultant bidding
03/08/2010	Host Country DNA Prior Approval, Sri Lanka
20/10/2010	Signing construction contract with China National Electricity Equipment Corporation
18/08/2011	CDM consultant contract sign
13/01/2012	Validation contract sign with DOE
06/03/2012	Host Country DNA Approval for PDD, Sri Lanka
20/01/2012	Upload PDD for GSC
15/01/2013	Construction start date (expected)
2017	As per Ceylon Electricity Board (CEB) Annual Report 2017 page 60 – “The construction work is in Progress in parallel at Main Dam Site, Main Tunnel, Diversion Tunnel and Power House Site and the project is scheduled to complete in year 2019”
2018	As per Ceylon Electricity Board (CEB) Annual Report 2018 page 71 –

	"The construction work is in Progress in parallel at Main Dam Site, Main Tunnel, Diversion Tunnel and Power House Site and the project is scheduled to complete in year 2019. The Physical Progress to date is 60%"
August 2020	As per the project progress review meeting report, 74.79% work has been completed
December 2020	Project participant is expecting to start the project activity by December 2020

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>> In order to calculate the baseline, project emission and leakage, and hence the emission reduction, the consolidated methodology ACM0002 (Version 13.0.0) is applied in conjugation with the "Tool to calculate the emission factor for an electricity system (Version 07.0.0). It includes the following steps;

1. Calculation of baseline emissions;
2. Calculation of project emissions;
3. Calculation of leakage emissions;
4. Calculation of emission reduction.

1. Calculation of baseline emission

Step 1: Identify the relevant electricity systems

As per section B.4 and B.5, the identified business as usual scenario is the continued generation of power by the CEB national grid system, and baseline emissions are those produced as a result of this. Therefore, as per para 17 (a) option 1, the CEB grid is identified as the relevant electricity power system.

Step 2: Choose whether to introduce off-grid power plants in the project electricity system

Option I: Only grid power plants are included in the calculation.
Off-grid power generation is not significant. Therefore, Option I has been selected.

Step 3: Select a method to determine the operating margin (OM)

The calculation of the operating margin emission factor (EFgrid,OM,y) can be based on one of the following methods:

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

The simple OM method can only be used if any one of the following requirements is satisfied:

(a) Low-cost/must-run resources constitute less than 50 per cent of total grid generation (excluding electricity generated by off-grid power plants) in: 1) average of the five most recent years, and the average of the five most recent years shall be determined by using one of the approaches described below; or 2) based on long-term averages for hydroelectricity production (minimum time frame of 15 years);

(b) The average amount of load (MW) supplied by low-cost/must-run resources in a grid in the most recent three year (i.e, average of $EGLCMR_y$ 8760, $EGLCMR_y$ −18760, $EGLCMR_y$ −28760) is less than the average of the lowest annual system loads (LASL) in the grid of the same three years (i.e. average of LASLy, LASLy-1, LASLy-2).

As per para 40 a, 2, Approach 2) the low-cost/ must run resources constitute less than 50% of total generation in long-term average for hydroelectricity production. 15 years period has been selected to calculate the long-term average for hydroelectricity production. Therefore, Simple Operating Margin method has been selected for the calculation of OM.

The Long-Term Average for Hydroelectricity Production in MWh				
Year	CEB Hydro	SPP Hydro	Gross generation (MWh)	% of Hydro Electricity Production
1998	3,527,500.0	6,254.0	5,180,196.9	
1999	3,777,900.0	17,784.0	5,712,724.2	
2000	2,812,795.6	43,137.0	6,371,835.0	
2001	2,787,623.0	64,711.0	6,280,216.0	
2002	2,588,624.0	103,459.0	6,831,299.0	
2003	3,190,038.0	120,291.0	7,702,879.0	
2004	2,754,700.0	205,577.0	8,067,573.0	
2005	3,222,512.0	277,445.0	8,843,995.0	
2006	4,289,533.0	344,649.0	9,443,257.0	
2007	3,602,871.0	344,000.0	9,845,079.0	
2008	3,700,491.0	428,929.0	9,987,127.1	
2009	3,355,603.0	525,492.0	9,961,583.0	
2010	4,988,461.0	645,802.0	10,783,244.0	
2011	3,972,672.0	600,571.0	11,582,754.7	
2012	2,726,721.0	564,687.0	11,878,837.9	
2013	6,010,099.0	908,390.0	12,005,538.3	44%
2014	3,649,721.0	902,174.0	12,830,108.3	42%
2015	4,904,410.0	1,064,719.0	13,211,066.8	42%
2016	3,481,940.0	738,843.0	14,342,716.9	41%
2017	3,075,218.0	945,448.0	14,966,639.7	40%
Source: CEB Statistical Reports (https://ceb.lk/publication-media/annual-reports/en)				

For the simple OM, the emission factor can be calculated using either of the two following data vintages:

(a) Ex ante option: if the ex ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDMPDD to the DOE for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the CDM-PDD for validation;

(b) Ex post option: if the ex post option is chosen, 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. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year y-2 may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

In this project, the Simple OM has been calculated EX ANTE option, using the data vintages for years y, as the full generation-weighted average for the most recent 3 years for which data are available at the time of PDD submission. The data vintage and calculated OM will not be changed during the crediting period.

Step 4: Calculating the operating margin emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (t CO2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

The simple OM may be calculated by one of the following two options:
(a) Option A: Based on the net electricity generation and a CO2 emission factor of each power unit; or
(b) Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system. Option B can only be used if:
(i) The necessary data for Option A is not available; and
(ii) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and
(iii) Off-grid power plants are not included in the calculation (i.e. if Option I has been chosen in Step 2)[11]*.*

Option A and A1 has been selected to calculate the simple OM. The calculations are based on the net electricity supplied to the grid by all power plants serving CEB grid, not including low cost/ must-run power plants/units, and based on the net electricity generation and a CO_2 emission factor of each power unit, as follows:

$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$	(Tool 07 version 07.0, Equation 3)

[11] Tool 07: Tool to calculate the emission factor for an electricity system version 07.0, paragraph 46 and 47

$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$	(Tool 07 version 07.0, Equation 4)

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO2 emission factor in year y (t CO2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EFEL_{,m,y}$	CO2 emission factor of power unit m in year y (t CO2/MWh)
$EFco2_{,m,i,y}$	Average CO2 emission factor of fuel type i used in power unit m in year y (t CO2/GJ)
$FC_{i,m,y}$	Amount of fuel type i consumed by power unit m in year y (Mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)
$EF_{co2,i,y}$	CO2 emission factor of fuel type i in year y (t CO2/GJ)
m	All power units serving the grid in year y except low-cost/must-run power u nits
i	All fuel types combusted in power unit m in year y
y	The relevant year as per the data vintage chosen in Step 3

Step 5. Calculate the build margin (BM) emission factor

In terms of vintage of data, project participants can choose between one of the following two options:

(a) Option 1 - for the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period;

(b) Option 2 - For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

To calculate the build margin (BM) emission factor for an electricity system option (1) has been selected:

The sample group of power units *m* used to calculate the build margin has been determined as per the following procedure, consistent with the data vintage:

Steps to calculate the build margin	Justification
(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5 units) and determine their annual electricity generation (AEGSET-5-units, in MWh);	• The set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently were identified as SET5 units; • Annual electricity generation of SET5 units in MWh was determined as AEGSET-5-units
(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20 per cent of AEGtotal (if 20 per cent falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET20 per cent) and determine their annual electricity generation (AEGSET-≥20 per cent, in MWh);	• Annual electricity generation of the project electricity system, excluding power units registered as CDM project activities was determined as AEGtotal, in MWh; • The set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20 per cent of AEGtotal were identified as SET20 per cent (if 20 per cent falls on part of the generation of a unit, the generation of that unit was fully included in the calculation). • The annual electricity generation of SET20 per cent was determined as AEGSET-≥20 per cent, in MWh;
(c) From SET5-units and SET20 per cent select the set of power units that comprises the larger annual electricity generation (SETsample); Identify the date when the power units in SETsample started to supply electricity to the grid. If none of the power units in SETsample started to supply electricity to the grid more than 10 years ago, then use SETsample to calculate the build margin. In this case ignore Steps (d), (e) and (f).	• From SET5-units and SET20 per cent, the set of power units that comprises the larger annual electricity generation was identified as SETsample; • SET20 per cent, the set of power units has larger annual electricity generation. Therefore, it was identified as SETsample; • None of the power units in SETsample started to supply electricity to the grid more than 10 years ago. September 2014 is the date when the first power units in SETsample started to supply electricity to the grid. Therefore, SETsample was used to calculate the build margin and Steps (d), (e) and (f) were ignored.

Most-Recently Added Five Power Units (SET5 Units) 2017

1	Berannawa	464.368
2	Loggal oya (dendro)	79.804
3	Demodara	3536.037
4	Nedunkulam Solar	10435.009
5	Campion	2570.72
Total generation AEGSET-5-units (MWh)		17085.938
Total grid generation (MWh)		14130128.27
Share of grid generation		0.12%
Source: CEB Statistical Reports (https://ceb.lk/publication-media/annual-reports/en)		

SET20 Per Cent		
Total Grid Generation (MWh) 2017		14130128.27
SET20 per cent	Year of Addition	
Coal Power phases II & III	Sep-14	3564366
Bathalayaya Biomass power	May-14	36613.215
Small Power Producers	Jan-Dec 2014	53171.967
Small Power Producers	Jan-Dec 2015	42767.66
Wind power	Jan-15	29564.825
Solar Power	Oct - Dec 2016	39493.832
Small Power Producers	Jan - Dec 2016	57253.33
Small Power Producers	Jan - Dec 2017	29828.455
Dendro Power	Sep-17	79.804
Solar Power	Jan - Dec 2017	44718.564
Total Generation as AEGSET-≥20 per cent in MWh		3897857.652
AEGSET-≥20 per cent to Total Grid Generation		27.59%
Source: CEB Statistical Reports (https://ceb.lk/publication-media/annual-reports/en)		

Unit Set	Generation in MWh (2017)
AEGSET-5-units	17085.938
AEGSET-≥20 per cent	3897857.652

AEGSET-≥20 per cent is greater than AEGSET-5-units. Therefore, AEGSET-≥20 per cent was selected as SETsample.

The build margin emissions factor is the generation of weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available. It is calculated as follow:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

(Tool 07 version 07.0, Equation 15)

Where:

EF*grid,BM,*y = Build margin CO2 emission factor in year *y* (tCO2/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*= CO2 emission factor of power unit m in year *y* (tCO2/MWh)

m = Power units included in the build margin

y = Most recent historical year for which power generation data is available. The CO2 emission factor of each power unit m (EFEL,m,y) has been determined as per the guidance in Step 4 (a) of

the tool for the simple OM, using para 49 (a) Options A1, using for y the most recent historical year for which electricity generation data is available, and using for m the power units included in the build margin

Step 6. Calculate the combined margin (CM) emission factor

As per para 81 of the tool, the calculation of the combined margin (CM) emission factor (EFgrid,CM,y) can be based on one of the following methods:
(a) Weighted average CM; or
(b) Simplified CM.

(a) Weighted average CM method has been selected.
The combined margin emissions factor is calculated as follow:

$EF_{grid,CM,\ y} = EF_{grid,OM,\ y} \times w_{OM} + EF_{grid,BM,\ y} \times w_{BM}$	(Tool 07 version 07.0, Equation 16)

Where
EF*grid,CM,y*= Combined margin CO2 emission factor in year *y* (tCO2/MWh)
EF*grid,OM,y*= Operating margin CO2 emission factor in year *y* (tCO2/MWh)
W_{OM}= Weighting of operating margin emissions factor (%)
EF*grid,BM,y*= Build margin CO2 emission factor in year *y* (tCO2/MWh)
W_{BM}= Weighting of build margin emissions factor (%)

As per paragraph 86 (b) of Tool 07.0 – for Hydro plants:

Crediting Period	wOM	wBM
First	0.50	0.50
Second	0.25	0.75

- EFgrid,y for the 1st crediting period : 0.8108 tCO2/MWh.
- EFgrid,y for the 2nd and 3rd crediting period : 0.8666 tCO2/MWh.

Detail calculation sheet has been provided separately which shows the calculation process of grid emission factor of Sri Lanka.

Calculation of Baseline Emission (BEy)

The baseline emissions (BEy in t CO2e) are the product of the baseline emission factor (EFy in tCO2e/MWh) multiplied with the electricity supplied by the project activity to the grid EGy in MWh)

$$BEy = EFy \times EGy$$

In addition to the guidelines in the ““Tool to calculate the emission factor for an electricity system”, ACM0002 states:

$$BEy = EGPJ,y \ . \ EFgrid,CM,y \ (6)$$

Where:

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

EGPJ,y = Quantitiy of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)

EFgrid,CM,y- = Combined margin CO2 emission factor for the grid connected power generation in year y calculated using the latest version of the "tool to calculate the emission factor for an electricity system" (tCO2/MWh).

Project Emissions

For hydropower project, project emission is calculated by considering the power density. If the power density is well above 10 W/m2, PEHP,y = 0

$\mathrm{PD} = \frac{CAP_{pj} - \mathrm{Cap}_{\mathrm{BL}}}{A_{PJ} - A_{BL}}$	(5)

PD = 35000000W / 37700 m2 = 928.38 W/m2

Where:

PD = Power density of the project activity, in W/m2

CapPJ = Installed capacity of the hydro power plant after the implementation of the project activity (W)

CapBL = Installed capacity of the hydro power plant before the implementation of the project activity (W).

For new hydro power plants, this value is zero

APJ = Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m2)

ABL = Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m2). For new reservoirs, this value is zero. Since the power density is calculated as follows:

Power density = Installed Capacity / Inundated area

Leakage

As per methodology ACM0002, leakage need not be considered,

Therefore:

LEy = 0 **Project emission reductions**

Emission reductions are calculated as follow;

ERy = BEy - PEy (11)

Where:

ERy = Emission reductions in year y (t CO2e/yr)

BEy = Baseline emissions in year y (t CO2/yr)

PEy = Project emissions in year y (t CO2e/yr)

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data or parameter.)

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	The combined margin emissions factor for The Democratic Socialist Republic of Sri Lanka
Source of data	Data published by Ceylon Electricity Board and IPCC 2006 guidelines. https://ceb.lk/publication-media/annual-reports/en
Value(s) applied	0.8108
Choice of data or measurement methods and procedures	This value has been calculated as per the "Tool to calculate the emission factor for an electricity system (Version 07.0.0)" as specified by the applicable methodology (ACM0002 Version 13.0.0).
Purpose of data	To calculate baseline emissions
Additional comment	

Data/Parameter	Power generation
Data unit	MWh
Description	Total power generation in year 2015, 2016 and 2017 and long-term averages for hydroelectricity production (minimum time frame of 15 years) to calculate Simple Operating Margin.
Source of data	Ceylon Electricity Board, Annual reports and webpage. https://ceb.lk/publication-media/annual-reports/en
Value(s) applied	Given in emission factor calculation sheet
Choice of data or measurement methods and procedures	Sri Lanka is defined as the geographical project boundary of the project activity. According to the "Tool to calculate the emission factor for an electricity system", the option of Simple OM can be used where low-cost/ must run resources constitute less than 50% of the total grid generation or based on long-term averages for hydroelectricity production (minimum time frame of 15 years). Long-term averages for hydroelectricity production (minimum time frame of 15 years) was used
Purpose of data	To calculate baseline emissions
Additional comment	Official data is used

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	Methodology ACM0002 (Ver.13.0.0)
Value(s) applied	0
Choice of data or measurement methods and procedures	As the project is a new hydro power plant, Cap_{BL} is zero according to the methodology ACM0002 (Ver. 13.0.0)
Purpose of data	To calculate power density
Additional comment	

Data/Parameter	A_{BL}
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero
Source of data	Methodology ACM0002 (Ver.13.0.0)
Value(s) applied	0
Choice of data or measurement methods and procedures	As the project is a new hydro power plant, A_{BL} is zero according to the methodology ACM0002 (Ver. 13.0.0)
Purpose of data	To calculate power density
Additional comment	

B.6.3. Ex ante calculation of emission reductions

>>Based on the proposed project's feasibility study and recent average auxiliary consumption, the annual electricity generated and supplied to the national grid is 120749 MWh. According to the formula to be used for the calculation of baseline emission and emission reduction, the annual emission reduction as well as total reduction for the first crediting period has been calculated as follow:

BEy = EFy × EGy (4)

ERy = BEy – PEy - LEy (8)

ERy = (120749× 0.8108) – 0 – 0 = 97,903 tCO2e

Thus the annual emission reductions attributable to the proposed project activity are 97,903 tCO2e.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
1	97903	0	0	97903
2	97903	0	0	97903
3	97903	0	0	97903
4	97903	0	0	97903
5	97903	0	0	97903
6	97903	0	0	97903
7	97903	0	0	97903
Total	**685321**	0	0	**685321**
Total number of crediting years	7 × 3			
Annual average over the crediting period	97903	0	0	97903

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	$EG_{facility,y}$
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y
Source of data	Electricity meters
Value(s) applied	[XX]
Measurement methods and procedures	The following parameters shall be measured; i) The quantity of electricity supplied by the project plant to the grid will be measured by electricity meter reading; and ii) The quantity of electricity delivered to the project plant from the grid (it is denoted as $EG_{impt,y}$ in the figure B.4)
Monitoring frequency	Regular measurement of electricity meter and keeping monthly record
QA/QC procedures	The energy meter will be calibrated as per the CEB standards[12] which are national standards and meterreading data at the Broadlands hydropower project site will be cross checked with the CEB system control and operations data
Purpose of data	To calculate baseline emission reductions
Additional comment	Digital net export and import meter will be installed so that accurate measure can be taken. Total amount of imported electricity will be deducted from the total amount of electricity exported to the grid to get net generation.

Data/Parameter	$EG_{imt,y}$
Data unit	MWh
Description	Annual electricity imported from Sri Lankan National grid in emergency, if needed.
Source of data	Electricity meter

[12] The Ceylon Electricity Board (CEB) is a corporate body establish in terms of Parliament No. 17 of 1969 as the successor to the Department of Government Electrical Undertakings. It is a national institution charged with the responsibility of generating, transmitting and distributing electrical energy to reach all categories of consumers nationwide (Source: CEB Annual Report 2010. https://www.parliament.lk/papers_presented/24102012/annual_report_ceylon_electricity_board_2010.pdf). Therefore, CEB is a national body and its standards are the national standards.

Value(s) applied	[XX]
Measurement methods and procedures	This parameter will be measured by an electricity meter
Monitoring frequency	This will be continuously measured and monthly recorded. All data collected as part of monitoring should be achieved electronically and be kept at least for 2 years after the end of the last crediting period.
QA/QC procedures	The data is monitored through the meter and checked by electricity purchase receipts. The meter should be calibrated following the equipment provider instruction as well as national regulation.
Purpose of data	To calculate baseline emission reductions
Additional comment	This value will be deducted from the total amount of electricity supplied to the grid to get net generation of the power plant.

Data/Parameter	Cap_{pj}
Data unit	W
Description	Installed capacity of the hydropower plant after the implementation of project activity
Source of data	Onsite measurement (ex-ante value is from feasibility study report but it will be measured onsite)
Value(s) applied	[XX]
Measurement methods and procedures	Determine the installed capacity based on recognized standards (according to ACM0002)
Monitoring frequency	Annually after the project is operational
QA/QC procedures	-
Purpose of data	To calculate power density
Additional comment	

Data/Parameter	A_{pj}
Data unit	m^2
Description	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full
Source of data	Project site (ex-ante value is taken from feasibility study report)
Value(s) applied	[XX]
Measurement methods and procedures	Measure from topographical survey, map or satellite picture whichever is convenient
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	To calculate power density
Additional comment	

B.7.2. Sampling plan

>> Data and parameters monitored in section B.7.1 above are to be monitored by electricity meters which installed by the project owner. Therefore, this procedure does not apply.

B.7.3. Other elements of monitoring plan

>> To comply with the CDM rules, a final monitoring plan will be prepared prior to the start of crediting date on as-build project activity. The following indicate plan is provided in the meantime. It will address the following aspects:

1. Data to be monitored

In this PDD, emission factor of the Project is determined ex ante. Therefore, the net electricity supplied to the grid by project is defined as the key data to be monitored. According to the requirement of monitoring methodology, the installed capacity, and area of reservoir measured in the surface of the water after the implementation of the project should also be monitored during the crediting period.

2. Implementation of the monitoring plan

Ceylon Electricity Board will set up a CDM team comprising of persons from relevant departments, which will be responsible for monitoring all of the parameters mentioned in this session. The team will have following structure and responsibility to comply with the monitoring requirement.

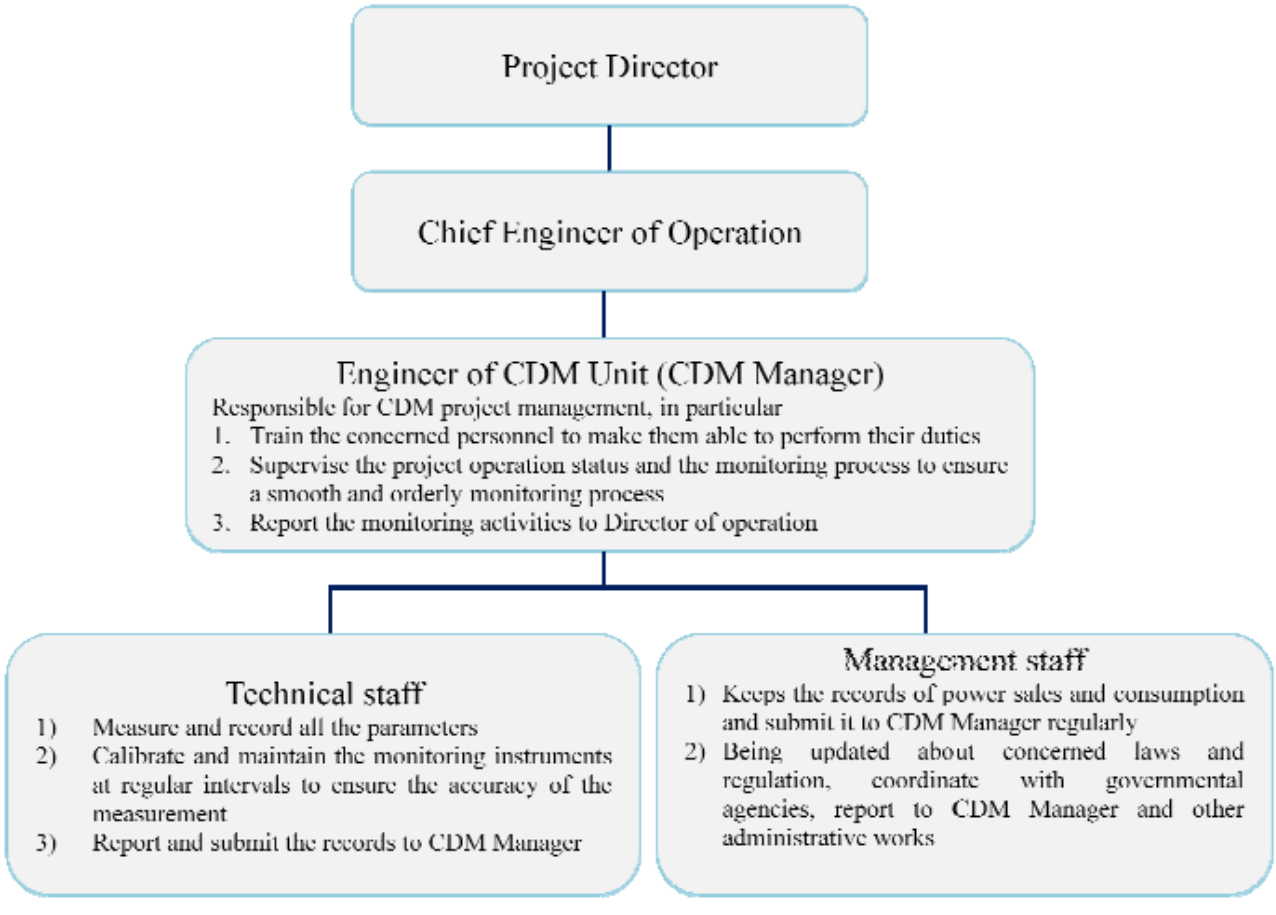

Figure B.3: Management structure of monitoring plan

The specific role and responsibility of each staff will be as follow:

Tasks description	Management staff	Technical staff	Engineer (CDM Unit)	Chief Engineer Of Operatio

				n
Monitoring activity				
Recording monitored data	√			
Quality Assurance and Quality Control				
Verification of data monitored (consistency and completeness)		√		
Ensuring adequate training of staff		√		
Ensuring adequate maintenance and Ensuring calibration of monitoring instruments		√		
Data archiving: ensuring adequate storage of data monitored (integrity and backup): 2 years after the end of the crediting period			√	
Identification of non-conformance and corrective/preventive actions and monitoring plan improvement		√		
Emergency procedures		√		
External audit			√	
Calculation of GHG emission reductions and reporting				
Processing of data and calculation of emission reductions			√	
Monitoring report: management review of monitoring report (internal audit)			√	
Overall management and final approval				√

Net electricity generation of the project will be measured and monitored through the use of on-site metering equipments at the outgoing feeders of the hydropower plant.

The document management system will be developed to ensure adequate document control for CDM purposes. The dedicated engineer (CDM Unit) of the project developer is responsible for checking the data (collection, storage and archive).

3. Monitoring meters

The electricity exported to national grid and the electricity imported from the grid will be continuously monitored through electricity meter installed at the project site, the net electricity generation is the difference between the amount of electricity export and import. As per ACM0002 (Ver. 13.0.0), total electricity produced by the project activity does not need to be monitored if the

power density exceeds 10W/m2. So internal load (auxiliary consumption) will not be monitored but the project owner will keep record of international consumption for their record. The amount of generation reduction in polpitiya hydropower plant due to construction of Broadlands hydropower plant dam, does not need to be monitored as very conservative approach has been applied during ex-ante calculation and the maximum possible loss thus calculated will be used throughout the crediting period. Although engineering calculation shows that there is only 11GWh loss in Polpitiya power station but PP has considered the maximum water level in Broadlands power plant dam for the conservative estimation of loss in Polpitiya power plant and amount of loss is estimated to be 15.79GWh. This value is deducted from Broadlands power plant's annual generation while calculating net generation and baseline GHG emissions. For the conservative calculation maximum water level elevation (121m) in Broadlands power plant dam site is applied rather than applying mean water level elevation (118m). Huge precipitation in the concerned watershed throughout the year is not possible hence there is not any possibility of water accumulation in dam at maximum level all around the year but PP for conservative way of calculation considered the maximum level all around the year only to calculate the reduction loss in Polpitiya power station but not the generation increase in project activity. Following figure shows the arrangement of measuring equipment;

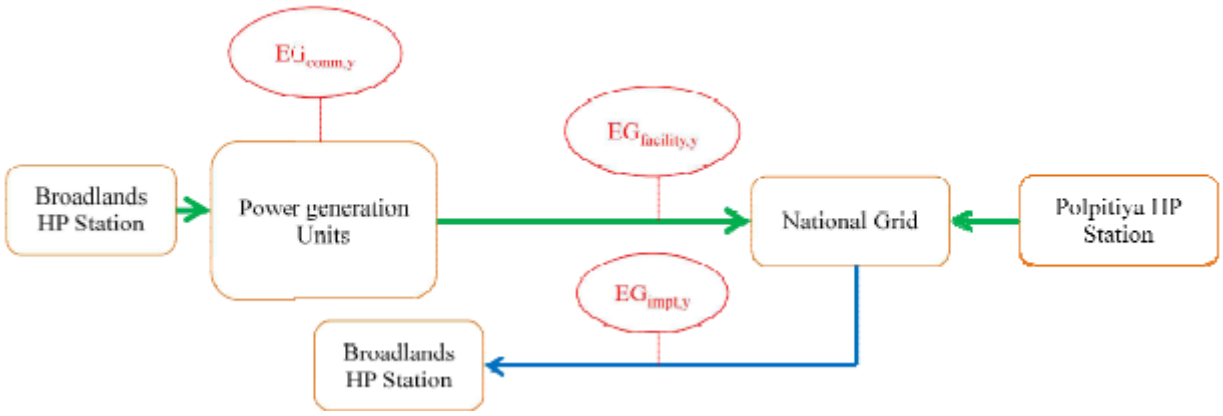

Figure B. 4: Monitoring points and equipment

4. Quality assurance and quality control

The quality assurance and quality control procedures involves of data monitoring, recording, maintaining and archiving, and monitoring equipment calibration. The electricity exported to and imported from Sri Lankan national grid will be monitored through calibrated metering equipment at the project site. Data of net amount of generation received from the meter reading at the project site will be cross checked with the system control and operations data published by CEB. Although the project will be under CEB ownership, it project will be operated under its own management system so the data can be cross checked with CEB official data which publishes net amount of electricity supplied to the national grid from each project in Sri Lanka. Calibration of Meters and

metering should be implemented according to relevant standards given by equipment providers or CEB standards, and all the records should be documented and maintained by the project owner for DOE's verification.

5. Procedures of abnormal condition and reporting

The CDM Manager will take real time monitoring on the operation status of metering meters to ensure that any abnormality could be detected and the corresponding measures of processing, reporting and recording will be taken in time. The abnormal meters will be repaired immediately and must be calibrated according to the CEB standards before being put into use again. If temporary measuring meter is required, calibrated meter will be used.

Problem occurred in monitoring and measurement process will be recorded and reported to Director of operation. Consequently, corrective action will be taken. All the relevant records of exception handling will be kept by the project owner during the crediting period and two years after for DOE's verification.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>> Construction agreement was signed with a Chinese construction company on 2010/10/20 and it is officially considered as project activity start date.

C.2. Expected operational lifetime of project activity

>> 50 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>> Renewable

C.3.2. Start date of crediting period

>> 25/12/2020[13]

C.3.3. Duration of crediting period

>> 7 years

[13] Long Term Generation Expansion Plan 2018-2037, Table 2.1

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> The Environmental Impact Assessment report of the project prepared by National Building Research Organization (NBRO) during feasibility study stage of the project and approved by Central Environmental Authority (CEA) on November 08, 2006 and extended on February 05, 2010 concludes that no serious impacts on the natural/social environment will occur by the implementation of the project. This is partly because the project is run-of-river type hydropower development and extends in a limited area and the number of houses to be demolished is small (16).

The project will reduce the environmental impacts associated with the production of electricity by substituting fossil fuels with water – a source of renewable energy.

Major conclusions of the approved EIA report are summarized as follow:

A. Impacts on Ecological Resources

a.1. Flora

In almost all project activities in their construction phase, the clearance of vegetation is likely to occur to the "edge" of the different vegetation types; that is, the "core" area is not affected or cleared. In this project, even the powerhouse area only lies within the boundary of the proposed forest reserve and so only the edge is affected. Hence, the exact impact on threatened species, endemic species, or species richness of the site will be less or insignificant compared to a situation when the core area, the dense forest, is disturbed.

During the operation period, there will be no vegetation clearance, but there will be a succession of vegetation, and the places cleared will regain their vegetation.

a.2. Fauna

Terrestrial fauna

The anticipated impact on threatened, endemic and migrant species is considered low for a number of reasons. The area to be cleared is located at the edge of the forest and therefore only a small area of land will be cleared. Furthermore, the degree of current human disturbance is high in these areas so the species present are already tolerant of disturbances. Species with very high sensitivity do not live in these areas but in the dense forest, and none of the project activities has a direct impact on terrestrial fauna in the dense forest.

In the operation phase there will be no specific activities that have an impact on the terrestrial fauna. The roads will be generally avoided by species due to traffic. Other areas will be gradually replaced with fauna depending on the habitat availability.

Aquatic fauna

Due to the reduction of water flow during the operational phase, larger species of fish may avoid the river section between the weir and the dam site. This reduction in the flow will also change the

conditions of the riverbed, leading to some changes in species richness, diversity and ecological balance. The impact may be considered important only for the river section as none of these species are restricted to Maskeliya Oya and hence the reduction in water volume is unlikely to drive any of these species toward extinction. Furthermore, most of the fresh water species that are endemic and threatened are found mostly in the tributaries that feed the river, which will not be impacted by the reduction of water flow.

B. Impact on Physical Resources

b.1. Impact on land use

Illegal encroachment into state lands is a common phenomenon during the pre-construction stages of many similar development projects. This impact may be anticipated in this project as well. The state lands within the project boundaries might be encroached with the prime intention of compensation and those outside the boundaries will be encroached as a result of land value increasing with the new road and the bridge infrastructure under the proposed project.

b.2. Impact on surface water

During the construction period the effluents from the camp areas may be considered important contributors to BOD.

The septic pits and soakage pits, if sited without considering adequate absorption fields, appropriate distance to watercourses and peak flood levels, may introduce high BOD seepage into streams and river water. In addition, the blasting process may generate effluents containing N and P. If these effluents are disposed of directly in watercourses, an increase in N and P in the river might be anticipated. However, the likelihood of producing eutrophication impacts such as algal blooms is low due to high flow velocity and dilution effects.

During construction periods, contaminated with oil and grease generated from construction areas may enter the river. The runoff may carry oil-contaminated water to the river, causing a deterioration of water quality.

C. Impact on Human Environment

c.1. Impact on socio-economic conditions

During the construction period, household income as well as expenditure levels can be expected to increase with the enhanced income-generating activities and the creation of new employment opportunities by the project. These employment opportunities will be short- or medium-term, but the experience and savings that may be gained by workers would help them secure long-term employment opportunities elsewhere.

The impact on agriculture is insignificant. In the dam/weir sites in Zone-1, some cultivated land such as tea plantation land will be affected, but the affected extent is low. In the powerhouse site in Zone-1, most of the land is taken from forest, thus the extent of agricultural land loss is low.

Due to the increase in household income and the influx of labor, the demand for food, goods and services will increase, and the project will have a positive impact on businesses other than whitewater rafting.

c.2. Resettlement

Forty nine families with population of around 140 from dam site and five families with population of around 20 will require resettlement to another location. The existing houses and shops will be demolished by the construction of the dam, conduit, road and powerhouse. They all agreed to in-kind compensation, and they are willing to accept an alternative site, bare land nearby their present location. 49 families in dam site will receive about 8.7 hectares of land about 1km far from their present location and 5 families living nearby power house and switch ward will be resettled in a land which is about 5 km far from the present settlement.

D. Proposed Mitigation Measures

d.1. Flora and Fauna

During the construction phase, illegal tree felling should be prevented. An officer appointed by the divisional secretariat may control illegal activities hampering natural vegetation in the area. In addition, cases in which a party is found guilty should be handled according to the regulations Felling of Trees Control Act No. 9, 1951 and its amended Act No. 1 of 2000 and the Flora and Fauna Protection Ordinance.

After construction, the disturbed areas should be re-vegetated. The abandoned areas and open areas of the permanent facilities could be re-vegetated with forest species that can be found in both weir/dam sites.

Plants of threatened species can be cut if official permission is received. Therefore, it will be possible to cut plants of threatened species if there is no other choice during construction. And it is suggested that the CEB plant the same species at a proper site.

A valve will be installed at the proposed dam to ensure the environmental flow.

d.2. Land use

Illegal encroachments will be done by declaring an interim development period under legislation, under which the all the development activities within the particular declared zone will be controlled.

d.3 Surface water

The effluents from cooking, toilets, etc., are never to be directly disposed of in open waters. It may be best to send them through closed drains into suitably designed soakage pits and septic pits. The sites for soakage pits and septic pits should be selected taking the following into consideration: peak flood levels, soil overburden, ground water table, slopes, distance from the

watercourse, etc. Garbage such as kitchen waste, sanitary waste or any such domestic waste is never to be disposed of in on-site open disposal yards. Such waste should be essentially stored in closed systems to prevent rain contact and access by animals such as cats, rats, etc.

To prevent the oil pollution, the location of the machinery service yard may be determined an adequate distance from the natural drainage paths (river, stream, springs, etc.), and above the maximum flood levels recorded within three to five years. General machinery maintenance guidelines should be prepared to have specific procedures to maintain machinery, and appropriate training of the staff is also necessary.

d.4. Resettlement

The resettlement plan has been prepared based on the following principle.
- to ensure that affected residents and employees will improve their income and livelihood or at least restore them to their original levels, and
- to ensure that the affected people will exceed their original housing conditions or at least restore them to their original standards, and that the production conditions of affected enterprises and shops as well as working environment will be restored or improved.

After consultation with affected households and individuals by concerned, all the households agreed to have in-kind compensation and rehabilitation. During the field interviews, all affected families pointed out that they are willing to accept an alternative site close to their present location. An empty land parcel of about 8.7 hectares, adjoining the Broadlands Tea factory, bordering the main road and the river, was identified for their alternate site.

E. Other Impacts

Other environmental pollutions such as air and noise pollution will have insignificant impacts to the environment and can be excluded for consideration. The traffic dust should be controlled through following approach; random excavation should be forbidden and excavated area should be cleaned in time, powder materials for implementation should be covered, the vehicles should be covered and the road should be watered frequently.

D.2. Environmental impact assessment

>> The proposed project will not result in any significant negative environmental issues and the EIA of the project has been approved by the Central Environmental Authority, Sri Lanka.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>> To inform the stakeholders about the environmental impact that will be caused by Broadlands hydropower, CEB had conducted several briefing to the following stakeholders;

- Relevant officers of the Central Government
- Relevant officers of the local governments
- Community leaders and the general public (village headmen, leaders of the community based organizations, entrepreneurs and the general people)

Table E. 1: Consultation meetings and briefing summary

Date	Target people	No. of Participants
18/09/2002	Officers of the relevant Divisional Secretary's Divisions and Pradesiya Sabas	14
26/09/2002	Kalugala, Dagampitiya and Polptiya GN Divisions	27
09/10/2002	Polytiya GN Division	25
12/10/2002	Dagampitiya GN Division	7
28/10/2002	Divisional secretaries of Yatiyantota and Ambegamuwa Kerale, Other relevant officers	8
10/11/2002	All the relevant GNs	10
06/11/2002	Officers of the relevant Pradesiya Sabas	16
11/11/2002	Inverstors (hoteliers, water rafting company, tea factory owners, industrialists)	10
17/11/2002	Environmental officers	2
14/12/2002	Kithulgala South	10
10/03/2003	Relevant GMs and village headmen	8
10/03/2003	Relevant GMs	5
13/11/2003	All the relevant people (dam/weir site)	51
13/11/2003	All the relevant people (powerhouse site)	31
15/05/2010 – 17/05/2010	All relevant household in dam / weir site and power site	49 + 5 families

Significant numbers of stakeholders were participated in consultation and briefing sessions and they raised questions and requests on the project, but the responses of the participants were positive.

As the consultation meeting with local stakeholders were initially organized about 8 years ago, the project owner carried out another consultation meeting in 2010 to know their recent opinion and whether they have different opinion than that of the earlier one. But all participants had the same opinion and they are in favour of project and want to see the project be implemented soon.

E.2. Summary of comments received

>> During the consultation meetings with various stakeholders, the stakeholders did not identify any major negative impact of the project. Local stakeholders anticipated that the project would have many positive aspects specially resettlement in comparatively better location, compensation of related costs.

In 2010, Broadlands Hydro power project survey team visited all 54 houses individually and filled the survey form by asking all the questions in it from the house owner and witnessed by the village head. Then the form was given to the house owner to check whether the information are in order and to confirm by signing the form. Then the filled forms were submitted to the village head and the Divisional Secretary (DS) in the area respectively for their approvals for the given information by the house owners.

- All attendees agreed that the project will create new jobs;
- Most of the participants identified that there were no significant negative impacts from the project;
- Local stakeholders agreed that the project will provide better lively hood facilities to them and the compensation will make them able to start new business or resettle in better condition;
- Their responses were very positive towards the project and they are found to be very supportive both in the survey in 2003 and 2010;

In general, local stakeholders have positive responses on project. They are expecting positive social, economic and environmental advances through the project.

Local stakeholders in all consultation meetings including in 2010 proposed mainly the following things;

- To provide them equal or better facilities as enjoyed by them at present
- To resettle them in a place as much as nearer to their original living place
- Support to improve their income generation

E.3. Consideration of comments received

>> In response of comments received from local stakeholders, the project owner has prepared proper action plan to address every issues along with environmental matters. Following are the major actions that will be taken by project owner;

- To select a land nearer to their present living place

New resettlement sites have been selected within a maximum distance of 1 kilometre from the present settlement of the dam site area (49 families) and 5 kilometres from the present settlement of the power house& switch yard area (5 families). Therefore the majority of affected people will not lose the access to common facilities they have been enjoying hitherto.

- To provide a Commercial/Common facility building

It is decided to construct a two story building which has commercial shops and public transport station in the ground story and the common facility building in upper story. Resettle plan already agreed to provide a plot of land of maximum extent as allowed by the government regulation.

- Allowing them to decide on their own of receiving a house or money instead.

Depending on the outcome of survey the affected people can decide whether they want to have building and land plot or equivalent amount of money or share of them depending on the valuation their existing properties done by Chief Governmental Valuer. In doing so, people are free either to continue their current professions or can have another business opportunity using the amount received as compensation.

Besides that the project owner will pay much attention to the comments and suggestions of stakeholders and will put all of the measures listed in the EIA into effect during construction and operation to protect the local environment. The project owner assured that:

- The project's construction and operation would be in line with the environmental and health and safety laws of Sri Lanka;
- As the project is run-of-river with a run-of-river reservoir, its environmental impact is relatively low;
- Affected land and vegetation will be recovered by reforestation.
- The project owner will also keep regular communication with the public regarding the construction and operation of this project.

The monitoring agency has been formed to reduce to implement the mitigation plan and monitoring plan.

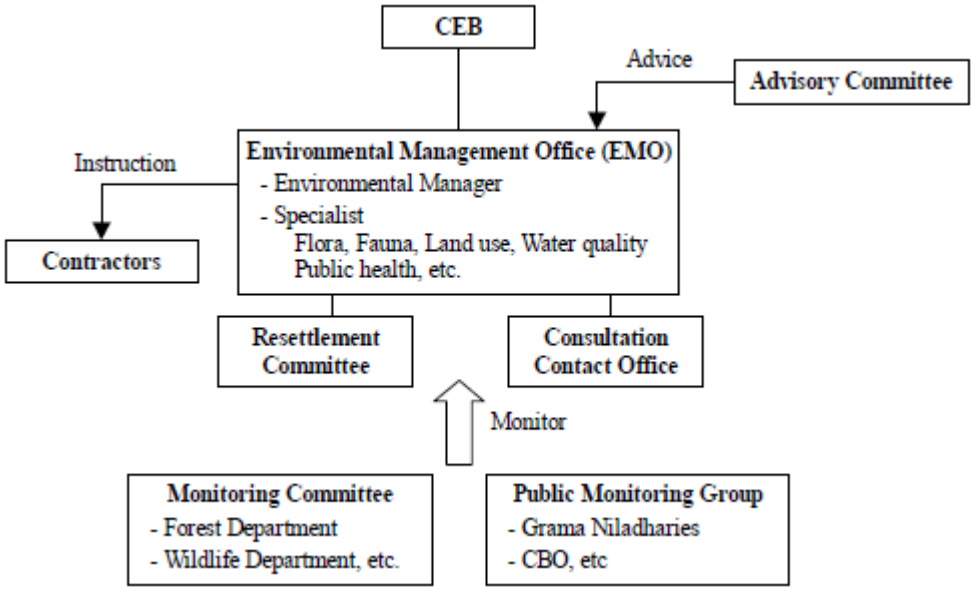

Figure E. 1. Organization for Monitoring

The house hold that will be affected from the construction of project will be relocated in the better place and appropriate compensation will be given to all families. Project owner has also committed that new land will be provided in a plotted form so that it will increase the business opportunity in the community. Construction cost of house will be also provided based on the current market value. House rent and other necessary costs will be paid to the people who will have to resettle temporarily during construction phase.

In summary, project owner has committed to provide better lively hood facility to the affected people.

SECTION F. Approval and authorization

>> Letters of approval from host party i.e. Sri Lanka and other party i.e. Republic of Korea is already received and submitted to DOE.

Appendix 1. Contact information of project participants

Organization name	Broadlands Hydropower Project, Ceylon Electricity Board
Country	Sri Lanka
Address	No. 251-4B, Dharmapala Mawatha, Colombo 07 Building Postcode 00700
Telephone	+94112677557/+94112682845
Fax	+94112677557
E-mail	pdbhp@sltnet.lk
Website	www.ceb.lk / www.bhpceb.lk
Contact person	Kamal Laksiri

Organization name	Ecoeye Co. Ltd
Country	Republic of Korea
Address	404-1 Beakhyeon-dong, Bundang-gu, Seongnam-si, Gyeonggi-do
Telephone	+82-31-710-7346
Fax	+82-31-716-1848
E-mail	sangsun_ha@ecoeye.com
Website	www.ecoeye.com
Contact person	Sangsun Ha

Appendix 2. Affirmation regarding public funding

No public funding is involved in this project activity

Appendix 3. Applicability of methodologies and standardized baselines

This section is left blank intentionally.

Appendix 4. Further background information on ex ante calculation of emission reductions

This section is left blank intentionally.

Appendix 5. Further background information on monitoring plan

This section is left blank intentionally.

Appendix 6. Summary report of comments received from local stakeholders

This section is left blank intentionally.

Appendix 7. Summary of post-registration changes

Permanent changes
Proposed changes are permanent in nature and have been documented in the revised PDD.

I. Corrections
Corrections as per paragraph 232 of the the Standard: CDM project standard for project activities Version 02.0 have been made. These changes, as summarize below are either editorial in nature or related to the project information:

- Date of completion of PDD has been updated;
- CDM-PDD-FORM (Version 11.0 which is used for this document) has been updated;
- Incorrect reservoir area was reported incorrectly in the registered PDD due to typing error. The same and calculation of power density has been corrected.;
- Contact information of project participants has been updated

II. Changes to the start date of the crediting period
The project start has been delayed due to the delay in getting Land Acquisition and Legal clearance and hindrance due to Social issues. Proposed changes are related to the change in start date of the crediting period.
Start date of the crediting period in the registered PDD is 1 June 2015 which has been changed to 25 December 2020.

As per the paragraph 236 of the CDM project standard for project activities version 02.0-" *If the proposed change to the start date of the crediting period of a registered CDM project activity is more than two years, or more than four years for a registered CDM project activity hosted by a least developed country, the project participants shall":*

a) Demonstrate that the project activity remains additional
Project cost has increased because of the delay. The electricity tariff has increased from Lankan Rupees 11.30 to Lankan Rupees 16.63. However, the increase is not enough to make project financially attractive. Parameters - Total Investment, O & M Cost, Revenue, Net Generation and Tariff have been included in the sensitivity analysis. The sensitivity analysis shows that project remains additional to reasonable variations in the critical assumptions.
Impact of delay on the project Additionality is summarized below:

Investment Cost Comparison

Particular	Amount USD	Source
Initial Investment Cost	82027771	Original Contract
Revised Investment Cost	97494069	Revised Contract
The cost has increased. Therefore, project remains additional	15466298	Difference

Initial IRR as per the Registered PDD [14]

Scenario	-10%	0%	+10%
Benchmark	15.58%	15.58%	15.58%
Total Investment	12.76%	11.62%	10.66%

[14] Registered IRR Sheet

O & M	11.70%	11.62%	11.54%
Net generation	10.47%	11.62%	12.73%
Tariff	10.47%	11.62%	12.73%

Revised IRR as per the Revised Investment Cost and Tariff [15]

Scenario	-10%	0%	+10%
Benchmark	15.58%	15.58%	15.58%
Total Investment	9.95%	9.00%	8.20%
O & M Cost	9.08%	9.00%	8.91%
Revenue	8.02%	9.00%	9.94%
Net Generation	8.02%	9.00%	9.94%
Tariff	8.02%	9.00%	9.94%

Conclusion

The delay has increased the project cost, resulting in IRR which is lower than the benchmark. The sensitivity analysis shows that project IRR will remain lower than the benchmark. Therefore, the project remains additional even after the delay.

b) Demonstrate that the original baseline scenario established in the registered PDD remains valid, or update the baseline scenario using the latest data, as appropriate

Grid emission factor has been reassessed as per the Tool 07: Tool to Calculate the Emission Factor for an Electricity System Version 07.0. Therefore, value of grid emission factor and emission reduction have been updated accordingly in the relevant sections;

c) Demonstrate that substantive progress has been made by the project participants to start the project activity

Substantive progress has been made in the implementation of the project activity; the project is in commissioning stage.

- As per Ceylon Electricity Board (CEB) Annual Report 2017 page 60 – "*The construction work is in Progress in parallel at Main Dam Site, Main Tunnel, Diversion Tunnel and Power House Site and the project is scheduled to complete in year 2019"*;
- As per Ceylon Electricity Board (CEB) Annual Report 2018 page 71 – "*The construction work is in Progress in parallel at Main Dam Site, Main Tunnel, Diversion Tunnel and Power House Site and the project is scheduled to complete in year 2019. The Physical Progress to date is 60%";*
- As per the project progress review meeting. 74.79% of the work has been completed August 2020;
- Project participant is expecting to start the project activity by December 2020[16].

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

Changes, as per paragraph 238 of the the Standard: CDM project standard for project activities Version 02.0 have been made. These changes, as summarize below does not deviate from the applied methodologies, the applied standardized baselines, or the other applied methodological regulatory documents:

- Calibration of meters will be done as per the CEB standards which are national standards and in line with the applied methodology[17]. The Ceylon Electricity Board (CEB) is a corporate body establish in terms of Parliament No. 17 of 1969 as the successor to the Department of Government Electrical Undertakings. It is a national institution charged with the responsibility of generating, transmitting and distributing electrical energy to reach all categories of consumers nationwide (Source: CEB Annual

[15] Revised IRR Sheet

[16] Long Term Generation Expansion Plan 2018-2037, Table 2.1

[17] *"All measurements should be conducted with calibrated measurement equipment according to relevant industry standards."* Page 15, ACM0002 / Version 13.0.0

Report 2010. https://www.parliament.lk/papers_presented/24102012/annual_report_ceylon_electricity_board_2010.pdf). Therefore, CEB is a national body and its standards are the national standards.

IV. **Changes to project design**

Changes, as per section 8.3.5 of the the Standard: CDM project standard for project activities Version 02.0 have been made:

a) Description regarding 33 kV transmission line has been added. The purpose of 33 kV line is to import grid electricity to the plant.
Electricity import has been identified as the monitoring parameter on page number 25 of the registered PDD. This monitoring parameter is unchanged. The proposed change adds further technical details.

Impact of change as per paragraph 242 of the the Standard: CDM project standard for project activities Version 02.0 has been summarized below:

Parameter	Impact
(a) The applicability and application of the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents with which the project activity has been registered;	Electricity import has been identified as the monitoring parameter on page number 25 of the registered PDD. This monitoring parameter is unchanged. The proposed change adds further technical details and therefore, no change in the applicability criteria or application of the applied methodology.
(b) The compliance of the monitoring plan with the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents;	Electricity import has been identified as the monitoring parameter on page number 25 of the registered PDD. This monitoring parameter is unchanged. The proposed change adds further technical details and therefore, improves compliance of the monitoring plan of the applied methodologies
(c) The level of accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan;	Electricity import has been identified as the monitoring parameter on the page number 25 of the registered PDD. This monitoring parameter is unchanged. The proposed change adds further technical details and therefore, improves accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan
(d) The additionality of the project activity;	The proposed change adds further technical details and therefore, no impact on the additionality of the project activity
(e) The scale of the project activity.	No change in scale of the project

b) In Table A.1 discharge and in Table A.2 - rated discharge (per unit) of turbine and runway speed of generator have been corrected. In the registered PDD the values were typed incorrectly. Now they have been corrected.

Impact of change as per paragraph 242 of the the Standard: CDM project standard for project activities Version 02.0 has been summarized below:

Parameter	Impact
(a) The applicability and application of the applied methodologies, the applied standardized baselines	Ratings of power generating equipment have been corrected. Therefore, no change in the applicability

and the other applied methodological regulatory documents with which the project activity has been registered;	criteria or application of the applied methodology
(b) The compliance of the monitoring plan with the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents;	Ratings of power generating equipment have been corrected. Therefore, no change in compliance of the monitoring plan of the applied methodologies
(c) The level of accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan;	Ratings of power generating equipment have been corrected. Therefore, no change in level of accuracy and completeness in the monitoring of the project activity compared with the requirements contained in the registered monitoring plan
(d) The additionality of the project activity;	Ratings of power generating equipment have been corrected. Therefore no impact on the additionality of the project activity
(e) The scale of the project activity.	No change in scale of the project

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).

Version	*Date*	*Description*
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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