Project design document form for CDM project activities

(Version 05.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Nam Lik 1 Hydropower Project
Version number of the PDD	Version 09
Completion date of the PDD	26/09/2014
Project participant(s)	Hydro Engineering Co. Ltd.
Host Party	Lao Peoples' Democratic Republic
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectoral Scope 1 – Energy Industries Baseline methodology : ACM0002 Version 15.0.0
Estimated amount of annual average GHG emission reductions	122,145 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project is designed to meet the objective of relieving the present shortage of power in the existing transmission and distribution grid, thereby making Laos less dependent on imports from Thailand and Vietnam. However, those provinces which are connected to the Vietnamese grid are not connected to the Central grid where this project is located, and therefore the Vietnamese power generation has not been included in the grid emissions factor. The project will further develop the Greater Mekong Regional Grid, making the whole of the grid less dependant on power generation through the burning of fossil fuels. The installed capacity of Nam Lik 1 Hydropower Project is 61MW with annual power generation of 248.6 MWh.

The overall purpose of the project is the generation of electricity based on renewable energy sources. The electricity will be delivered to the regional grid consisting of Central Lao C1s and the Northern part of Thailand. The projected income from the sale of CERs will contribute not only to the socio-economic situation of the region but also to sustainable development in Lao PDR. Furthermore, the hydro power generated will increase the share of renewable energy in the regional grid, replacing imported power generated by fossil fuels.

For Lao PDR, the project will add great benefit to the national economy and environmental sustainability while reducing CO_2 emissions in the regional grid consisting of the Thai Grid and Lao Central Grid.

Furthermore, implementation of this project in Lao PDR is carried out within an overall CDM capacity building project, thereby providing the Waters, Rivers and Environment Authority (WREA), Lao PDR, with necessary skills and know-how to utilize its CDM potential for further projects.

At the regional level, the local population currently has limited access to public services, telephone services, roads, water supply and electricity. This project also foresees the construction of a transmission line as well as new access roads and the upgrading of existing roads.

Consequently, a significant improvement of the infrastructure in the region is expected. An improvement in tourism is also anticipated due to these measures. In general, the project will provide significant local social benefits due to additional employment and business opportunities, better road access and electrification of the area.

All of the households in the vicinity of the project area will receive electricity which will drastically improve living conditions. Currently, the majority of households use kerosene for lighting and firewood for cooking.

The project will replace firewood consumption and save cutting down of trees contributing to the overall environmental sustainability of Lao PDR.

For Thailand, the project will contribute significantly to the achievement of the national sustainability goals:

- Socio-Economic wellbeing: The project will supply power to the Northern and Eastern Thailand grid which will contribute to reducing the shortages.
- Environmental wellbeing: The project activity will displace the power which would otherwise be generated from fossil fuel such as coal, diesel, gas etc.

A.2. Location of project activity

A.2.1. Host Party

Lao PDR

A.2.2. Region/State/Province etc.

Vientiane Province

A.2.3. City/Town/Community etc.

The nearest village is Ban Hin Heup

A.2.4. Physical/Geographical location

The Nam Lik 1 Hydropower Project is a relatively small project to be located in Hin Heup District, Vientiane Province. The main dam site is located 55km downstream from the Nam Lik ½ construction site and 9.6 km downstream of the Ban Hin Heup Bridge on the National Road 13 (18º37´N.Lat. 102º23´E.Long).

Detailed GPS co-ordinates are as follows :

Location	Latitude	Longitude
Dam and Power House	18°37'9.16"N	102°23'16.03"E
Hin Hoep Bridge	18°38'15.66"N	102°19'35.54"E
Hin Hoep Sub Station	18°38'11.84"N	102°19'31.78"E
Stakeholder Consultations	18°36'8.07"N	102°19'24.06"E
Downstream River Access	18°36'54.87"N	102°24'36.72"E

Although the final maximum surface area of the reservoir will be 11.5 km² (Figure 1) it should be noted that this is only (approximately) 7 km² more than the area flooded by the regular natural high water level of the river. The dam site, reservoir and the study area are not in the proximity of any National Biodiversity Conservation Areas (NBCA’s).

Detailed locations are shown in the maps below.

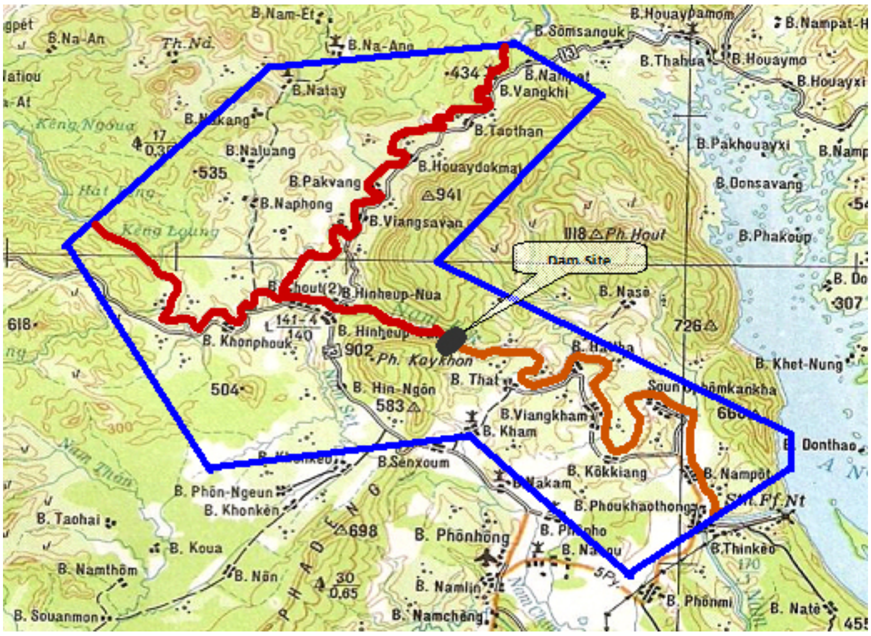


Figure 1 Map of Project Area 1

A.3. Technologies and/or measures

The baseline scenario is that the grid will continue to be supplied by power plants generating electricity using fossil fuels. This project will replace that generation with electrical power generated in a hydo electric plant which will result in zero CO2 emissions and only minimal greenhouse gas emissions from the reservoir. This is due to the project design and power density.

The layout of project mainly is comprised of three parts: headworks, diversion works and structures of power station. The headworks consist of retaining dam and power intakes; Diversion works consist of headrace tunnel, surge chamber and penstock, etc. The structures of power station comprise of main and auxiliary powerhouse and switch yard.

The project layout presents a Surface Powerhouse Scheme located on the Right. The layout includes[1]:

• A tunnel diversion based on a dry-season construction flood of 685 m3/s;
• A four gate spillway that will discharge the 1: 10 000 year flood without endangering the dam;
• A powerhouse with a concrete offset scroll case and two generating Kaplan units with total plant installed capacity of 60.4 MW at the HV outlets (or total generator nameplate ratings of 61.0MW). Assuming that the existing Nam Song Diversion Structure operation rules remain unchanged, the derived average energy production and plant capacity factor are respectively 248.6 GWh and 48%;
• Protection of the reservoir rim from slope failures is not necessary;
• The amount of sediments deposited into the future Nam Lik 1 reservoir is unlikely to result in significant loss of storage and will be significantly reduced when the Nam Lik 1/2 Development will be operational;
• The switchyard is a conventional arrangement located besides the powerhouse. It includes equipment for 115 kV transmission lines to the existing Hin Hoep substation;
• The generator operating voltage has been selected as 13.8 kV;
• A 700 person construction camp will be provided at the Nam Lik 1 site;
• Construction power is provided from the EdL existing 115/22 kV transmission line;
• Nam Lik 1 will provide first power 44 months after Main Civil (CW1) Works contract award;
• The turbine–generator contract and the construction power transformer contract must be awarded 8 months after Main Civil (CW1) Works contract award;

[1] Feasibility Study Page 1-5

In order to ascertain the long term sustainability of the know-how transfer, a training program is part of the CDM project activity. The training program is specifically designed to fit the requirements of the Project Authority in order to build up capacity in operation and maintenance of state-of-the-art hydroelectric equipment. Through the training program, cost optimal operation and maintenance of the hydropower plant can be achieved, maximising the lifetime of the equipment.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Lao Peoples Democratic Republic (Lao PDR) (host)	Hydro Engineering Co. Ltd.	No

A.5. Public funding of project activity

No public funding is foreseen for the implementation of the Nam Lik 1 Hydropower Project

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

The project follows the ACM0002 consolidated baseline methodology for grid-connected electricity generation from renewable sources, Version 15.0.0, Scope 1, EB 79.

Methodological tool "Tool to calculate the emission factor for an electricity system", Version 04.0.0, EB 75.

Methodological tool "Tool for the demonstration and assessment of additionality" Version 07.0.0, EB 70.

Methodological tool "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" Version 02, EB41

B.2. Applicability of methodology and standardized baseline

The baseline and monitoring methodology ACM0002 Version 15.0.0 is applicable to the proposed project, because the project meets all the applicability criteria stated in the methodology:

Condition: The project activity is the installation or modification/retrofit of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.

Project: The proposed project is a grid-connected hydropower generation project. Thus the project is in compliance with this applicability condition.

Condition: In case of hydro power plants:

- The project activity is implemented in an existing reservoir, with no change in the hose volume of reservoir.
- The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m2.
- The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m2.

Project: The project will create a new reservoir with a power density greater than 4 W/m2 (see also section B.3.). Thus the project is in compliance with this applicability condition.

The methodology ACM0002 (Version 15.0.0) is applicable to the proposed project, because the proposed project meets all the applicability criteria stated in the methodology:

Condition: The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

Project: The geographic and system boundaries for the relevant electricity grid, the Lao Central Grid and the Thai Grid, can be clearly identified and information on the characteristics of the grid is available.

The methodology includes two conditions that are not relevant to the proposed project activity:

Condition: Applies to grid connected electricity generation from landfill gas to the extent that it is combined with the approved "Consolidated baseline methodology for landfill gas project activities" (ACM0001).

Project: The project does not involve the generation of electricity from landfill gas and therefore this condition is not applicable.

Condition: 5 years of historical data (or 3 years in the case of non hydro project activities) have to be available for those project activities where modification/retrofit measures are implemented in an existing power plant.

Project: The project does not involve a modification/retrofit and therefore this condition is not applicable.

The methodology furthermore includes a number of disqualifying conditions, as indicated below:

Condition: The methodology is not applicable to project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site.

Project: The project does not involve an on-site switch from fossil fuels to a renewable source.

Condition: The methodology is not applicable to biomass fired power plants.

Project: The project is a hydropower plant and does not involve the firing of biomass.

Condition: The methodology is not applicable to hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is lower less than 4 W/m2.

Project: The power density of the project is greater than 4 W/m2

The methodology will be used in conjunction with the approved consolidated monitoring methodology ACM0002 (Consolidated monitoring methodology for grid-connected electricity generation from renewable sources). The latest version of ACM0002 (Version 15.0.0) has been applied.

 The project activity results in new reservoirs and the power density of the power plant, is greater than 4 W/m^2. The total installed capacity of the proposed project is 61.0 MW; the surface area at normal reservoir level is 11.5KM_2, but it should be noted that this is only (approximately) 7 km² more than the area flooded by the regular natural high water level of the river and the power density is based on this increase in the reservoir level and is calculated at 5.30 W/m^2

• The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

• Project activity does not involve switching from fossil fuels to renewable energy sources at the site of the project activity,

B.3. Project boundary

The project boundary for the purpose of calculating project and baseline emissions consists of the physical hydropower project site and the interconnected electricity grids of Lao PDR and Thailand. The only relevant emission source is the CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. For more details refer to the table below.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Electricity delivered to the grid by the operation of grid-connected power plants and by the addition of new generation sources.	CO_2	Yes	According to ACM0002 methodology: For the baseline determination, project participants shall only account CO_2 emissions from electricity generation in fossil fuel fired power that is displaced due to the project activity
		CH_4	No	
		N_2O	No	
Project scenario	Proposed Project	CO_2	No	Minor Emission Source
		CH_4	Yes	Minor Emission Source
		N_2O	No	Minor Emission Source

Table 1 - Greenhouse Gases Included in the Project Boundary

According to methodology ACM0002, the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to. The Project boundary is the Project site, the Southern Supply Area and EGAT Grid System (GS) with its extension into Lao PDR.

The CDM Executive Board (EB) in its 28th meeting in December 2006 clarified that the word "regional", in context of "regional electricity system" used in ACM0002, can also be interpreted as extending across international boundaries. The Board further clarified that trans-national electricity systems are eligible under ACM0002 and that the grid emission factor in this context shall be estimated for the "regional electricity system". Therefore, the EGAT Grid System with its extension into Lao PDR, can be considered as a "connected international electricity system", and determined as the "project boundary" for the proposed Project.

A flow diagram is provided which indicates the emission sources in relation to the implementation of hydropower project activities (Figure 3 below)

Project emissions associated with geothermal power plants (fugitive and combustion emissions) are not considered as the project involves a hydropower plant. In accordance with the ACM0002 methodology, project emissions from the reservoir have to be taken into account in case the power density of the project is between 4 W/m2 and less than or equal to 10 W/m2. The power density can be calculated as 5.3 W/m2 (see for details section B.6.1). In accordance with the ACM0002 methodology, emissions from the reservoir are taken into account in the calculation of emission reductions.

Figure 2 - Grid Interconnection Points (1)

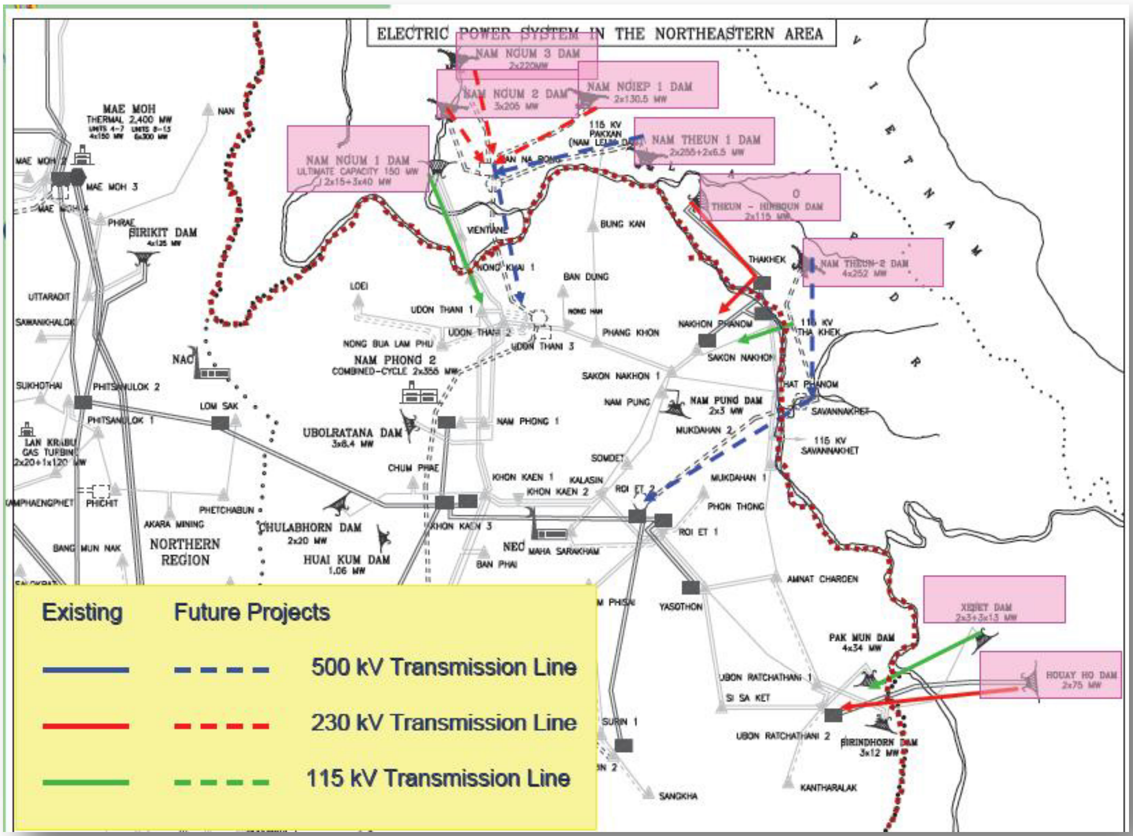


Figure 3 - Grid Interconnection Points (2)

A flow diagram is provided which indicates the emission sources in relation to the implementation of hydropower project activities (Figure 4 below)

Project emissions associated with geothermal power plants (fugitive and combustion emissions) are not considered as the project involves a hydropower plant. In accordance with the ACM0002 methodology, project emissions from the reservoir have to be taken into account in case the power density of the project is between 4 W/m2 and less than or equal to 10 W/m2. The power density can be calculated as 5.3 W/m2 (see for details section B.6.1). In accordance with the ACM0002 methodology, emissions from the reservoir are taken into account in the calculation of emission reductions.

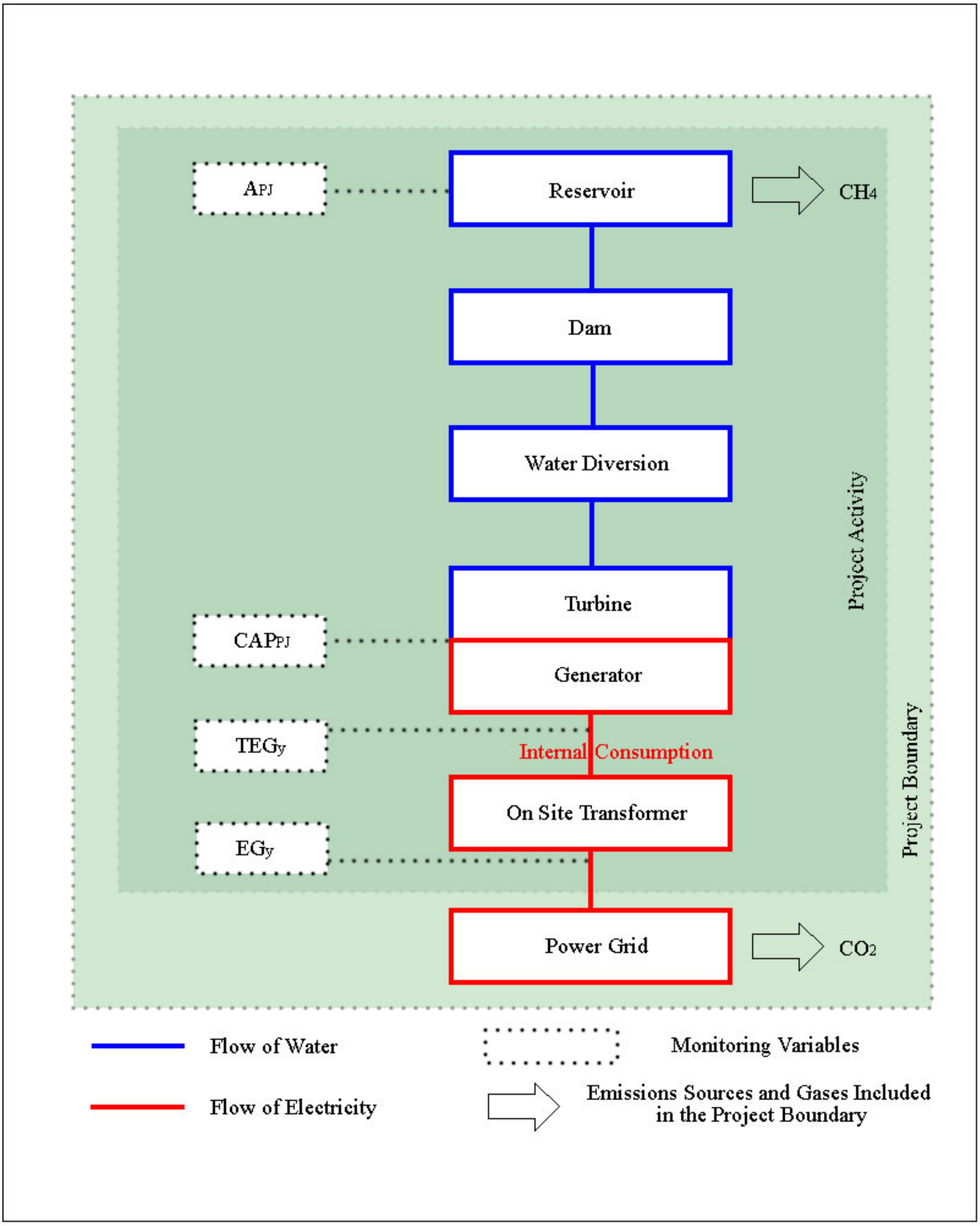


Figure 4 - Flow Diagram

B.4. Establishment and description of baseline scenario

Identification of the baseline scenario

If the project activity is the installation of a new grid-connected renewable power plant/unit, 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 an electricity system”.

ACM0002 also specified the step-wise approach for identifying the baseline for project activities which involve the retrofit or replacement of existing grid-connected renewable power plant/unit(s) at the project site.

The project is a newly built hydropower project, so the step-wise approach is not applicable.

The baseline scenario is determined by analysing the data from the electricity grid to which the Project causes emission reductions. The proposed Project is connected to the Southern Supply Area of Lao PDR, which forms an integral part and an extension of the EGAT Grid System in Thailand. Currently, electricity exchanges between Laos and EGAT Grid occur regularly without any transmission constraints. Therefore, (as justified above), the emission reductions will occur within the extended regional EGAT Grid System.

Approach

The approach selected in the baseline methodology checks the additionality of the project activity and determines the baseline emission factor for selected baseline scenario.

For grid connected electricity generation projects it is important to ascertain whether the project has some impact on the grid’s electricity generating pattern. It has been established in the CDM modalities and procedures that a combined margin (CM) which takes into account the operating margin (OM) and build margin (BM) can be used to determine the effect of the power project to the grid where:

a. The OM is the weighted average of all resources except low-cost/must-run facilities.
b. The BM is the generation-weighted average emission rate of the most recent 20% of plants built (on a generation basis) or the most recent five plants, whichever is greater.

Calculations for this combined margin are based on data from official sources from Electricite du Laos (EdL), the Electricity Generating Authority of Thailand (EGAT) and the Thailand Greenhouse Gas Office (TGO) which is the Thai Designated National Authority (DNA).

Power Supply Position – Lao PDR and Thailand Grid

The project will generate electricity to the public power grid of Lao PDR and the Thai grid.

Hence the hydro power generated from the project site being a must-run facility will replace the electricity generated from thermal power stations feeding into regional grid. Since hydro power is emissions free, the hydro power generated will save the anthropogenic Green House Gas (GHG) emissions that would have been generated by the fossil fuel based thermal power stations comprising coal, diesel, furnace oil and gas.

Identification of Baseline Scenario

The methodology lays down certain steps by which the baseline is determined. The baseline methodology identifies the project as being additional and not the baseline scenario. The methodology is designed to have the grid combined margin as the baseline scenario. The proposed hydro power plant will impact the combined margin which is calculated based on the weighted average of the operating margin (OM) emission factor and the build margin (BM) emission factor. Equal weights have been provided to the OM and BM by default as per the norms since the hydro power project is seen to have equal effects on both margins.

The project activity does not have any project emissions and does not take leakage into account as per ACM0002. Hence, the emission reductions that are calculated for the project activity are real.

The most plausible baseline scenario is identified in two steps. The first is the identification of all plausible alternatives. The second is the narrowing down of the plausible alternatives through assessment of barriers.

There are only two real and credible alternatives available to the project participants or similar project developers that provide outputs or services comparable with the Project. These are:

Alternative A: The proposed project activity undertaken without being registered as a CDM project activity;
and
Alternative B: Continuation of the current situation (no project activity or other alternative undertaken).

Alternative A, wherein the proposed project activity is implemented without the assistance of the CDM, can be ruled out as a credible alternative. As demonstrated quantitatively in Section B.5 below, the Project, in the absence of additional revenue is clearly not financially attractive for the project proponent.

Therefore, the remaining Alternative B, which is the non-implementation of the Project and the continued electricity generation from the Southern Lao Grid and the Thai Grid, is determined to be the baseline scenario.

The baseline scenario of the Nam Lik 1 Hydropower Project is the continued operation of the existing power plants and the addition of new generation sources on the Lao Central Grid and the Thai Grid to meet electricity demand. The project activity involves a construction of a zero-emission power source. Thus, the emission reductions are equal to the baseline emissions.

In accordance with the ACM0002 methodology, baseline emissions are equal to power generated by the project activity and delivered to the grid, multiplied by the baseline emission factor. The baseline emission factor is equal to the combined margin: a weighted average of the operating margin emission factor and the build margin emission factor.

There is ample evidence to show that the Project developer seriously considered the CDM from the very early stages of the project development.

The Project timeline is summarized in the table below.

Date	Detail
7.7.2006	MOU Signed between GOL and HEC, the Project Developer
19.9.2006	SNC Lavalin Commissioned to Prepare Feasibility Study
10.1.2008	MOU Extended until 15.4.2008
8.4.2008	PDA Signed between GOL and HEC
August 2008	Full Feasibility Study completed by SNC Lavalin which included a Tariff of USD 0.0754 per KWh.
21.8.2009	Tariff MOU Signed by EdL and HEC which agreed a lower tariff.

	Early investigations suggested that investors would not be interested at the tariff agreed with EdL
September 2009	CDM Consultants Approached by Financial Advisor to ascertain whether the project would qualify for CDM revenues
15.10.2009	PDA Extended to 15.3.2010
11.11.2009	Shareholder Agreement Drafted by HEC Lawyers
15.1.2010	CDM Consulants Appointed
February 2010	PPA Drafted by EdL
15.3.2010	PDA Extended to 9.9.2010
5.4.2010	CA Drafted by HEC Lawyers
30.7.2010	LOI Signed between Project Developer and Annex 1 Buyer
12.11.2010	PDA Extended to 9.3.2011
16.12.2010	Prior Consideration Form Submitted to UNFCCC
17.10.2012	Concession Agreed between Project Owner and EdL
06.02.2013	Concession Agreement formally signed and sealed
12.5.2013	The current status is that construction has not yet started but will commence at the end of the rainy season as all Concession Agreements and Power Purchase Agreements have been finalized.

Table 2 - CDM Timeline

All these facts show that CDM revenues were always considered crucial to ensure the project viability.

Uncertainties regarding CDM revenues are one of the main reasons why the project implementation planned for 2013 has been delayed. The current project schedule is to start operation in 2016, but further delays can also lead to a decision that the project will not be implemented.

B.5. Demonstration of additionality

The additionality of the project activity is further demonstrated and assessed according to the applied methodology ACM0002 using the latest version of the "Tool for the demonstration and assessment of additionality" Version 07.0.0, EB 70). The tool provides a step-wise approach to demonstrate and assess additionality of the Nam Lik 1 Hydropower Project and is applied by completing the following steps within this section:

Step 1: Identification of alternatives to the project activity consistent with mandatory laws and regulations

Step 2: Investment and sensitivity analysis to determine that the proposed activity is not the most financially attractive or is unlikely to be financially attractive;

Step 3: Barriers analysis to prove that there is at least one alternative scenario, other than the proposed CDM project activity, not prevented by any of the identified barriers;

Step 4: Common practice analysis to show essential distinction between the proposed CDM project activity and similar activities.

For the project activity, only Step 2 has been completed in order to give a sound overview of the project framework. Based on information about activities similar to the proposed activity, the common practice analysis is to complement and reinforce the investment and barrier analysis.

Step 1 - Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a - Define alternatives to the project activity

Realistic and credible alternatives to the proposed CDM project activity comparable with outputs and services include:

a) The proposed Project itself, but not undertaken as a CDM project activity.
b) Construction of a coal-fired power plant with equivalent installed capacity or annual electricity generation.
c) Construction of a power plant using other renewable energy with equivalent installed capacity or annual electricity generation feeding the grid.
d) Continuation of the current situation, where electricity is supplied by the EGAT Grid / Central Lao PDR grid and no project activity or other alternatives are undertaken.

Alternative b) construction of a coal-fired power plant with equivalent installed capacity or annual electricity generation.

Lao PDR has four isolated electricity networks. These include the Central Supply area where the Project is located, as well as the Northern Grid, the Southern Grid (see Section B.3). None of these networks are currently connected to each other. According to the Lao National Power Development Plan four thermal power plants are planned in the northern and central parts of the country but no suitable sites for thermal power plants have been identified in the Central Supply Area.

Therefore alternative b) is in compliance with the Lao PDR regulations, but is not a realistic and credible alternative for the Project and is eliminated from the baseline scenario.

c) Construction of a power plant using other renewable energy with equivalent installed capacity or annual electricity generation feeding the grid.

Other renewable energy options including biomass energy, wind, solar and geothermal as identified in alternative c) are not mature enough to handle the electricity demands in the Central Supply Area and would not be able to supply the equivalent amount of electricity as the proposed Project activity

Therefore, c) is not a realistic and credible alternative and is eliminated from the baseline scenario.

Therefore the outcome of Step 1a demonstrates that the identified realistic and credible alternative scenarios to the Project activity are Alternatives a), and d).

Sub-step 1b – Consistency with mandatory laws and regulations

In the development of the Lao power sector the government has identified two vital national priorities. The first priority encourages affordable and reliable power supply to both society and industry with community benefits. The other encourages the promotion of both hydropower and coal powered electricity exports (with both resources available abundantly in Lao PDR) in order to earn foreign exchange[2].

All the alternatives identified above are in compliance with applicable rules and regulations in Lao PDR and Thailand. Therefore, the proposed project activity is in competition with several other forms of energy generation in order to meet the growing demand in Thailand. The proposed project emits the least GHG emissions at the highest cost of generation compared with the alternatives mentioned. This will be shown in detail in the following steps.

Step 2 – Investment analysis

Determine whether the proposed project activity is not:

[2] Power System Development Plan for Lao PDR Final Report, Volume A : Main Report, August 2004, Pg: 21

(a) the most economical or financially attractive; or
(b) Economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs)

To conduct the investment analysis, the following sub-steps have been applied:

Sub-step 2a - Determine appropriate analysis method

The "*Tool for the Demonstration and Assessment of Additionality" (Version 7.0.0)* recommends three analysis methods, including simple cost analysis (Option I), investment comparison analysis (Option II) and benchmark analysis (Option III).

The proposed hydropower Project generates financial and economic benefits through the sales of electricity other than CDM related income, therefore the simple cost analysis (Option I) cannot be taken. The investment comparison analysis (Option II) is only applicable to projects where the alternatives are similar investment projects. The alternative baseline scenario of the proposed Project is the continuation of electricity supply from the Central Lao PDR / EGAT Grid System (alternative (d)) which is not considered to be an investment. Therefore, as per the Annex of the Additionality Tool (Version 7.0.0) the benchmark analysis (Option III) is chosen for this Project activity and the Project Financial Internal Rate of Return (FIRR) is used in analysing whether the Project is financially feasible or not.

Sub-step 2b – Option I. Apply simple cost analysis

Not applicable. The Project produces economic benefits other than just the CDM related income.

Sub-step 2b – Option II. Apply investment comparison analysis

Not applicable. The investment decision was not based on a choice between multiple project opportunities.

Sub-step 2b – Option III. Apply benchmark analysis

"Identify the financial indicator most suitable for the project type and decision context"

The decision by the project developer of whether or not to invest in the project was based on an evaluation of the project against several benchmark criteria.

The economic benchmark used by the Developer in its decision whether or not to implement the project is if the Project Internal Rate on Return (IRR) with the achievable electricity tariff can cover the Weighted Average Costs of Capital (WACC) for Nam Lik 1 Hydropower Project.

"Financial/economic analysis shall be based on parameters that are standard in the market, considering the specific characteristics of the project type"

The achievable tariff (USD/kWh) for power delivery from Laos hydro power plants to grid is the relevant parameter for the Project Developer to calculate the Project IRR and to decide whether to invest in a HPP project or not. This is standard for hydro power projects in Laos.

Based on the experience from Power Purchase Agreements (PPA) negotiated recently with EdL, and the Tariff MoU agreed between the Project Developer and EdL, the maximum achievable tariff for energy export to the grid is shown in the table below.

Year	Tariff	Year	Tariff
2014	$ 0.06599	2027	$0.03669
2015	$ 0.06634	2028	$0.03689
2016	$ 0.06669	2029	$0.03708
2017	$ 0.06704	2030	$0.03728
2018	$ 0.06740	2031	$0.03748
2019	$ 0.06776	2032	$0.03768
2020	$ 0.06812	2033	$0.03788
2021	$ 0.06848	2034	$0.03808
2022	$ 0.06884	2035	$0.03828
2023	$ 0.06921	2036	$0.03848
2024	$ 0.06957	2037	$0.03869
2025	$ 0.06994	2038	$0.03889
2026	$ 0.03650		

Table 3 - Tariff

A first price indication in the Feasibility Study was a levelized tariff of USD 0.0754 / kWh, but the actual maximum tariff as shown above, on a levelized basis, is just USD 0.0545 using the EdL suggested Discount Rate of 10%. In order to be conservative, the actual tariffs in the Tariff MoU have been used in the investment analysis in the PDD.

Sub-step 2c - Calculation and comparison of financial indicators:

1) Parameters needed for calculation of key financial indicators.

The financial assumptions of the Project are outlined in the Feasibility Study (undertaken by SNC Lavalin). These are as follows in Table 4 below. This resulted in the Project being not financially viable without the income from CERs (see Table 4 below).

	Unit	Amount	Source
Investment	US$	132,540,407	Feasibility Study
Share of Equity	%	30	JDA
Tax Rate	%	0	Concession Agreement
Concession Period	Years	25	Concession Agreement
Operation and Maintenance Costs	US$	1,000,000	Feasibility Study
Power Generation	GWh	248.60	Feasibility Study
Royalty	% Generation Revenues	1.00	Concession Agreement
Tariff	US$	Variable	Power Purchase Agreement
CER Price	US$	15	Estimate based on ECX Historical Prices

Table 4 - Investment Assumptions

Weighted Average Cost of Capital:

The benchmark Project IRR is based on the financing structure of the project (mixture of equity and debt) is calculated in the following way:

Cost of Equity	15%
Cost of Debt	6.25%
% Equity	30%
% Debt	70%
Tax Rate	0%
WACC	8.87500%

The following table shows the Project Internal Rate of Return (IRR) with and without CDM related income with the achievable electricity tariff (USD 0.545/Wh) and is calculated based on a comprehensive forecast of the cash flows throughout the project's life of twenty five (25) years as agreed in the Draft Power Purchase Agreement and the Draft Concession Agreement.

	Without CDM Related Income	**With CDM Related Income**
Project IRR	7.57%	8.95%

The Project IRR is then compared with the Weighted Average Cost of Capital (WACC) for the Nam Lik 1 project (8.875%). It can be demonstrated that without CDM revenues the project would be below the required benchmark. Additional CDM revenues would make the project economically viable.

The Guidelines on the assessment of Investment Analysis Version 05, EB 62, Report Annex 05 stated "local commercial lending rates…are appropriate benchmarks for a project IRR". Prime Lending Rates in Laos are summarized in the table below.[3]

Date	**Commercial Lending Rate**
31/12/2006	14.50%
31/12/2007	13.00%
31/12/2008	11.50%
31/12/2009	7.00%
31/12/2010	7.00%

As the trend in lending rates has been downward, and given the competitive international finance market, a rate of 6.25% has been used which is a conservative approach.

The Thai Minimum Lending Rates of 6.25%[4] were used to calculated the WACC as it is not realistic to assume that the debt financing would be sourced from a Lao Bank. This is partly because the rates are higher than those available elsewhere, and partly because Thai banks have an appetite for lending on a Project Finance. As a Project Company, Hydro Engineering Co. Ltd. does not have a S&P or Moody's Credit Rating, which limits sources of finance. Banks in Lao PDR will generally only lend on a long term basis to AAA Rated companies, and at higher interest rates[5].

A further measure to estimate the Benchmark Return was included by the UNFCCC was given in Annex 5 to EB 62 "Guidelines on the Assessment of Investment Analysis". For the power generating sector in Lao PDR, the default value for the cost of equity in nominal terms is 13.25%. In order to take the most conservative approach, inflation has not been taken into account and on this basis the WACC is 8.875%.
The lower of the two figures has been adopted and the applied benchmark is therefore 8.875%

[3] Source – The World Bank - http://siteresources.worldbank.org/INTEAPHALFYEARLYUPDATE/Resources/550192-1287417391641/EAP_Update_Oct2010_lao.pdf

[4] Source – Bank Of Thailand : http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=223&language=ENG

[5] Source - http://www.bcel.com.la/en/InterestRate.aspx?InterestRateDeptID=1

The Pre-Tax WACC was calculated using the following parameters :

The equation used for the above is shown below.

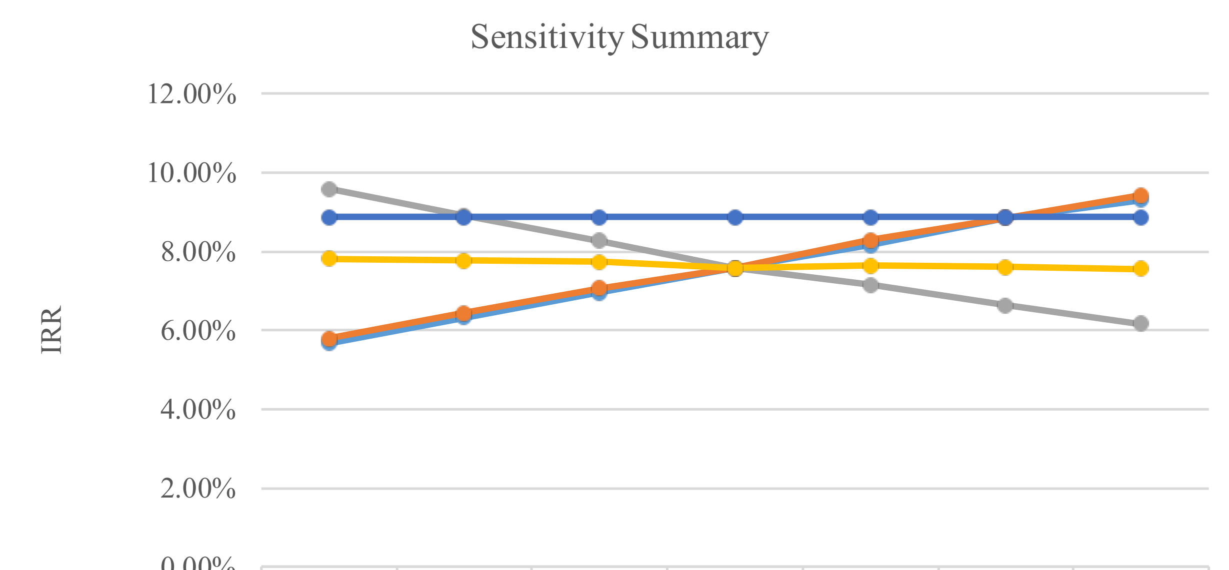
$$WACC = K_d \times (1\text{-}T) \times D/(D+E) + K_e \times E/(D+E)$$

Where

Kd = Cost of Debt
Ke = Cost of Equity
D = Debt
E= Equity
T = Tax

Sub-step 2d - Sensitivity analysis (only applicable to options II and III):

Please refer to the table below for a sensitivity analysis.



	-15%	-10%	-5%	0%	5%	10%	15%
Capacity	5.67%	6.33%	6.96%	7.57%	8.17%	8.86%	9.32%
Tariff	5.79%	6.44%	7.08%	7.57%	8.28%	8.86%	9.43%
CAPEX	9.59%	8.90%	8.27%	7.57%	7.15%	6.64%	6.17%
O&M	7.81%	7.77%	7.73%	7.57%	7.65%	7.61%	7.56%
Benchmark	8.88%	8.88%	8.88%	8.88%	8.88%	8.88%	8.88%

Figure 5 - Summary of Sensitivity Analysis

The table below shows the increases and decreases which would be required to achive the Benchmark IRR.

Increase / Decrease Needed to Exceed Hurdle Rates

Capacity / Output Increase	
Output Required	275,709,181
IRR	8.8750%
Increased Output	10.90%

Tariff Increase	
Current Levelized Tariff	$0.06
Tariff Required	$0.07
IRR	8.8750%
Tariff Increase	11.20%

Reduction in CAPEX	
Current CAPEX	$132,540,407
CAPEX Required	$117,960,962
IRR	8.8750%
CAPEX Reduction	12.56%

Reduction in O&M	
Current O&M	$1,000,000
O&M Required	($451,483)
IRR	8.8750%
O&M Reduction	-45.15%

Table 5 - Increase / Decrease Needed to Achieve Benchmark IRR

None of these alternatives are feasible for the reasons stated below;

1) The output is estimated based on the hydrological measurements at the site. Many years of data have been analyzed by hydrological engineers, and it is not realistic to assume that the flow of water will increase significantly as the data has been observed over a number of years. It would not be appropriate to install more powerful turbines as the turbines selected reflect the optimum turbine configuration for the given water flow. No investors would entertain the project without reliable output assessments from an independent hydrological engineer. An output increase of 10.90% to 275.71GWh may exceed the benchmark but this is simply not feasible. It is not feasible because the estimated output has already been set at the maximum which is realistically possible, as estimated by internationally respected consultants.
2) The Project Owner does not have a choice of offtaker – all power has to be distributed by the state owned utility, EdL. The tariff cannot be increased because the local population cannot afford a higher tariff. An increase of 11.20%, which is needed to exceed the benchmark return, is simply not possible.
3) The CAPEX is already at a minimum level. Prices for both civil and electrical mechanical contracts have been stable over a number of years.[6]
4) The O&M costs for the project are relatively minor and it is clear that no realistic or plausible amount of reduction in this area could achieve the benchmark.

Consequently, none of these alternatives are feasible.

[6] World Bank Statistics - http://data.worldbank.org/country/lao-pdr. These data show CPI inflation in Lao PDR to be as follows : 2008 – 7.30%;2009 – 0.035%; 2010 – 5.98%; 2011 – 7.58%; 2012 – 4.26%

In conclusion, since the project IRR is lower than benchmark, the project is considered as financially unattractive through investment analysis, so the proposed project is additional

Step 3 - Barrier Analysis

In addition to economic and financial barriers, the Nam Lik 1 Hydropower Project faces barriers that could readily prevent the implementation of a project of its type, and significantly impact the ultimate development and economics of the project. Among other impacts, the barriers restrict the availability of financing options for the project. At the same time, these barriers would be much less likely to prevent the implementation of alternative projects to generate an equivalent amount of energy in the regional grid consisting of Laos and Thailand – namely coal fired or natural gas power.

Sub-step 3a - Identify barriers that would prevent the implementation of type of the proposed project activity:

This step has not been undertaken because Additionality is proven by the above financial analysis.

Sub-step 3 b - Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

This step has not been undertaken because Additionality is proven by the above financial analysis.

Step 4 - Common Practice Analysis

Sub-step 4a: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity;

The installed capacity of the proposed project is 61MW, thus the applicable output range is from 30.00MW to 90MW.

Sub-step 4b: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N all. Registered CDM project activities and projects activities undergoing validation shall not be included in this step;

According to the definition of "applicable geographical area" given in Paragraph 5 of "Tool for the demonstration and assessment of additionality" (Version 07.0.0), the applicable geographical area covers the entire host country as a default. The proposed project is located in Lao PDR, thus, the applicable geographical area is the entire Lao PDR.

The starting date of the proposed project is 17/10/2012.

According to "Electricity Statistics in Lao PDR 2011", there are four hydropower projects with the installed capacity in applicable output range from 30MW to 90MW started commercial operation before 17/10/2012:

Item	Project Name	Installed Capacity	CDM Application
1	Nam Leuk	60MW	No
2	Nam Mang 3	40MW	No
3	Xeset 1	45MW	No
4	Xeset 2	76MW	Yes

Xeset 2 Hydropower Project has been developed as CDM project, so it is excluded.

Thus, the number N all is 3.

Sub-step 4c: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N diff.

All of the above plants are hydropower plants. These plants were built many years ago with ODA support and support from other Communist Countries, and cannot be considered as similar to this project.

The Nam Leuk Project was commissioned in 2000 and was built with aid from the Asia Development Bank and the Japanese Government.[7]

The Nam Mang 3 Project was built with assistance in the form of concessionary loans from the Chinese Government.

Xeset 1 was commissioned in 1990 and both technology and social and environmental safeguards have changed since then.

Thus, the number N diff is 3.

Sub-step 4d: Calculate factor F=1-N diff /N all representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

As analyzed in Step 2 and Step 3, the number N all and N diff are all 3.

Therefore, the factor F is calculated to be 0 (F =1-3/3=0), which is not greater than 0.2; and N all – N diff is also calculated to be 0, which is not greater than 3.

Therefore, the proposed project is not common practice in hydropower sector in Lao PDR

B.6. Emission reductions

B.6.1. Explanation of methodological choices

The baseline scenario is that electricity delivered to the national grid by the project would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation based mainly on coal and oil resources.

I. Project emissions *(PE_y)*

According to the ACM0002, the project emission for the Hydropower project includes the two proponents of emission from backup power and a new reservoir. The following formula is applied:

$$PE_y = PE_{FF,y} + PE_{HP,y}$$

Equation 1

$PE_{FF,y}$ backup power emissions

$PE_{HP,y}$ the emissions from the reservoir

The emissions from the reservoir ($PE_{HP,y}$)

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[7] http://www.adb.org/documents/nam-leuk-hydropower-project-lao-peoples-democratic-republic-loan-1456-laosf

Project Emissions

For hydro power project activities that result in new reservoirs, the project emissions is estimated as follows:

(a) If the power density (*PD*) of power plant is greater than 4 W/m2 and less than or equal to 10 W/m2:

$$PE_y = \frac{EF_{Res} \cdot EG_{facility,y}}{1000}$$

Equation 2

Where:

PE_y = Emission from reservoir expressed as tCO_2e/year
EF_{Res} = is the default emission factor for emissions from reservoirs, and the default value as per EB23 is 90 Kg CO_2e /MWh.
$EG_{facility,y}$ = Quantity of net electricity generation supplied by the project to the grid in year *y* (MWh/yr).

The power density of the project activity is calculated as follows:

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

Equation 3

Where:

PD = Power density of the project activity, in W/m2.
$\boldsymbol{Cap_{PJ}}$ = Installed capacity of the hydro power plant after the implementation of the project activity (W).
$\boldsymbol{Cap_{BL}}$ = Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero.
$\boldsymbol{A_{PJ}}$ = Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m2).
$\boldsymbol{A_{BL}}$ = 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.

Power density of Nam Lik 1 Hydropower Project

Plant	Installed Capacity (MW)	Reservoir Surface Area (m^2)	Power Density (W/ m^2)
Nam Lik 1 Hydropower Project	61.00	11,510,000	5.30

II. Baseline emissions *(BE_y)*

Baseline emissions include only CO_2 emissions from electricity generation by fossil fuel fired power plants that are displaced due to the project activity. It is calculated as follows:

$$BE_y = EG_{BL,y} \cdot EF_{grid,CM,y:}$$

Equation 4

Where:

BE_y	Baseline emissions in year *y* (tCO_2/yr)
$EG_{BL,y}$	Quantity of net electricity generation supplied by the hydropower plant to the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EF_{grid,CM,y:}$	Combined margin CO_2 emission factor of the national electricity grid in year y (tCO_2/MWh)

Calculation of the emission factor (EF) of the electricity grid

Version 04.0.0 of "Tool to calculate the emission factor for an electricity system" determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "operating margin" (OM) and "build margin" (BM) as well as the "combined margin" (CM), including 6 steps as follows:

STEP 1. Identify the relevant electricity systems.
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional).
STEP 3. Select a method to determine the operating margin (OM)
STEP 4. Calculate the operating margin emission factor according to the selected method.
STEP 5. Calculate the build margin emission factor.
STEP 6. Calculate the combined margin emissions factor.

Step 1 – Identify the Relevant Electricity System

This hydropower project will be connected to the provincial electricity grid of Lao PDR, which is operated by EdL. This Grid is connected to the National Power Grid of Thailand which is owned and operated by EGAT. This electricity grid is the unique transmission and distribution line, to which all power plants in Thailand are physically connected. Hence the interconnected grid of Lao PDR and Thailand is the project electricity system.

According to the Tool to calculate the emission factor for an electricity system, the relevant grid definition should be based on the following considerations:

1. Use the delineation of grid boundaries as provided by the DNA of the host country if available; or
2. Use, where DNA guidance is not available, the following definition of boundary:

In large countries with layered dispatch system (e.g. state/provincial/regional/national) the regional grid definition should be used.

According to above requirements, the regional grid (Lao PDR Grid and Thailand Grid) is selected as the project boundary.

Where the application of these criteria does not result in a clear grid boundary, use a regional grid definition in the case of large countries with layered dispatch systems (e.g. provincial / regional / national). A provincial grid definition may indeed in many cases be too narrow given significant electricity trade among provinces that might be affected, directly or indirectly, by a CDM project activity. In other countries, the national (or other largest) grid definition should be used by default.

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

There are 2 options in the tools to choose, including:

- Option I: Only grid power plants are included in the calculation.
- Option II: Both grid power plants and off-grid power plants are included in the calculation.

Because only the data of grid connected power plants is available, so Option I will be chosen for calculating the grid emission factor.

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

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

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

The data vintage which is used to calculation the Simple OM emission factor is the Ex-ante option of a 3- year generation-weighted average (2007, 2008 and 2009) that is the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period.

The simple OM (Option A) is used where low-cost / must run resources constitute less than 50% of the total grid generation in: 1) average of the five most recent years or 2) based on long-term norms for hydroelectricity production. Over 60% of the total grid generation (including total grid generation of EGAT and Lao PDR Grid) is produced from natural gas which is not a low-cost must run power resource.

Details of the Low Cost Must Run (LCMR) plants are shown in the table below.

Year	Thailand		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
2005	132,212	7,381	Thailand Greenhouse Gas Office
2006	139,422	9,961	Thailand Greenhouse Gas Office
2007	144,364	10,383	Thailand Greenhouse Gas Office
2008	145,232	9,116	Thailand Greenhouse Gas Office
2009	145,300	9,106	Thailand Greenhouse Gas Office

Year	Lao PDR		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
2005	1,715	1,715	EdL Statistics Yearbook 2010
2006	1,639	1,639	EdL Statistics Yearbook 2010
2007	1,398	1,398	EdL Statistics Yearbook 2010
2008	1,778	1,778	EdL Statistics Yearbook 2010
2009	1,656	1,656	EdL Statistics Yearbook 2010

Year	Total low-cost / must run power generation in the grid	Total power generation in the grid	Percentage of low-cost/must run
2005	9,096	133,927	6.79%
2006	11,600	141,061	8.22%
2007	11,781	145,762	8.08%
2008	10,894	147,010	7.41%
2009	10,762	146,956	7.32%

Table 6 Detail of LCMR Plants

The average percentage of LCMR over the 5 year period is 7.57% which is below 50% and therefore Option A has been selected.

Step 4 – Calculate the operating margin emission factor according to the selected method

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

- Option A: Based on data on the net electricity generation and a CO2 emission factor of each power unit,
- 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.

Because the necessary data for Option A is not available so Option B "*Calculation based on total fuel consumption and electricity generation of the system"* is used and then the simple OM emission factor is calculated as follows:

$$EF_{grid,\,OMsimple,\,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y}$$

Equation 5

Where:

$EF_{grid,OM,y}$	the Simple operating margin CO_2 emission factor in year *y* (tCO_2/GWh)
$FC_{i,y}$	Amount of fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
NCV_{iy}	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)
$EG_{,y}$	Net electricity generated and delivered to the grid by all power sources serving the system, not including low cost / must run power plants / units, in year *y* (MWh)
$EF_{EL,m,y}$	the CO_2 emission factor of power unit *m* in year *y* (tCO_2/GWh)
i	All fuel types combusted in power sources in the project electricity system in year *y*
y	The relevant year as per the date vintage chosen in step 3

Operating Margin emission factor of the most recent 3 years (2007, 2008 and 2009)

Year	2007	2008	2009	$EF_{grid,OM}$ (tCO2 / MWh)
Total emissions of the Grid (tCO2e)	83,513,708	84,097,036	82,192,233	**0.6148**
Total electricity delivered to the grid by fossil power sources (MWh)	133,982	136,116	136,194	

So the $EF_{grid,OM,y}$ is derived as follows:

$$EF_{grid,OM,y} \quad = \quad 0.6148 \text{ tCO2 / MWh}$$

Step 5. Identify the group of power units to be included in the build margin

The sample group of power units *m* used to calculate the build margin consists of either:

a) The set of five power units that have been built most recently, or
b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The group of power units that supply electricity to the grid most recently (sorted by the Commercial Operation Date (COD) which is the date when the power unit starts to supply electricity to the grid) and their annual quantity of electricity generation that comprise larger than or equal to 20% of total annual electricity generation (in year 2010) are shown in Table 7. Fuel consumption of these power units are shown in Table 8.

Power Generation by the Most Recently Built Power Plants		
Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	8,153.26	1/7/2008
Gulf Power Generation Co. Ltd. (Unit 1&2)	9,338.68	1/3/2008
BLCP Power Co. Ltd. (Unit 1&2)	10,018.13	1/2/2007
Summary	38,323.76	
As percentage of 2009 Grid Generation	26.38%	

Table 7 - Most Recently Constructed Power Plants

Fuel Type	Fuel Consumption		CO2 Emissions (kgCO2/Unit)	CO2 Emissions (tCO2)
	Unit	Volume		
Total				20,991,691
Natural Gas	scf.	223,468,679,056	0.0554	12,376,981
Lignite	ton	-	951.7230	-
Bituminous	ton	3,645,721	2,360.1150	8,604,321
Bunker	litre	-	3.0026	-
Diesel	litre	3,929,038	2.6441	10,389

Table 8 - Fuel Consumption of Most Recently Constructed Power Plants

As can be seen from Table 7 above, details the five most recently constructed plants which generate power on the grid can be summarized as follows :

Power Generation by the Most Recently Built Power Plants		
Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	8,153.26	1/7/2008
Gulf Power Generation Co. Ltd. (Unit 1&2)	9,338.68	1/3/2008
Total	28,305.63	

Table 9 Power Generation by 5 Most Recently Constructed Plants

Since the power generation from the units identified in Table 7 (Most Recent Grid Connected Power Plants which Represent 20% of Total Generation) is greater than the power generated by the five most recently constructed plants which supply the grid (Figure 11) those plants shown in Table 7 have been selected to calculate the Build Margin.

Step 6. Calculate the build margin emission factor

The BM emissions factor is the generation-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
follows:

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

Equation 6

Where:

$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

Then the $EF_{grid,BM,y}$ is derived as follows:

$$EF_{grid,BM,y} = 0.5478\ tCO_2/MWh$$

Step 7. Calculate the combine margin emissions factor

The CM emissions factor is calculated as follows:

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

Equation 7

Where :

W_{OM}	=	Weighting of OM emissions factor (%)
W_{BM}	=	Weighting of BM emissions factor (%)

For the proposed project, the following default values are used: W_{OM} = 0.5 and W_{BM} = 0.5 in the first crediting period, and W_{OM} = 0.25 and W_{BM} = 0.75 in the second and third crediting period.

So in the first crediting period, the CM emission factor is derived as follows:

$$EF_{grid,CM,y} = 0.6148 * 0.5 + 0.5478 * 0.5 = 0.5813$$

The baseline emission factor EF shall be fixed for the crediting period.

III. Leakage *(LE_y)*

Because the technology used in this project is neither transferred to nor transferred from another activity
leakage is considered to be zero (LE_y = 0).

IV. Reduction emissions *(ER_y)*

Emission reductions are calculated as follows:

$ER_y = BE_y - PE_y - LE_y$

Equation 8

Where:

ER_y Emission reductions in year y (tCO_2e/y).
BE_y Baseline emissions in year y (tCO_2e/y)
PE_y Project emissions in year y (tCO_2/y).
Le_y Leakage emissions in year y (tCO_2/y).

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$EF_{grid,OMsimple,y}$
Unit	tCO_2/ MWh
Description	Operating margin emission factor of the grid
Source of data	Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2007,2008 and 2009
Value(s) applied	0.6148
Choice of data or Measurement methods and procedures	Calculated as per "Tool to calculate the emission factor an electricity system" version 04.0.0 with 3-year vintage data and option of *ex-ante* calculation based on Simple Operating Margin Method
Purpose of data	Baseline emission
Additional comment	NA

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO_2/ MWh
Description	Build Margin emission factor of the grid
Source of data	Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2007, 2008 and 2009
Value(s) applied	0.5478
Choice of data or Measurement methods and procedures	Calculated as per "Tool to calculate the emission factor an electricity system" version 04.0.0 with *ex-ante* calculation based on sample group m comprising of 20% of the system generation (in MWh)
Purpose of data	Baseline emission
Additional comment	NA

Data / Parameter	$FC_{i,y}$
Unit	Million Tonnes, MMSCF, Million Litres
Description	Amount of each fossil fuel consumption by type of fuel

Source of data	Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2007, 2008 and 2009
Value(s) applied	See table A4 and A5 in Appendix 4
Choice of data or Measurement methods and procedures	For fossil fired generation units, EGAT and DEDE provide fuel consumption data. Likewise, the choice of data satisfies with the methodology in “Tool to calculate the emission factor an electricity system”
Purpose of data	Baseline emission
Additional comment	NA

Data / Parameter	$NCV_{i,y}$
Unit	TJ/Unit
Description	Net calorific value of the fuel combusted in grid based power plants used in the determination of the emission factor.
Source of data	Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2007, 2008 and 2009)
Value(s) applied	Varies for each fuel types
Choice of data or Measurement methods and procedures	Use for unit conversion.
Purpose of data	Baseline emission
Additional comment	Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO)

Data / Parameter	$EF_{CO2,i,y}$
Unit	tCO_2/TJ
Description	Emission Factor of Carbon dioxide gas emitted from fossil fuel combustion in grid based power plants used in the determination of the emission factor.
Source of data	default values from IPCC 2006
Value(s) applied	Varies for each fuel types
Choice of data or Measurement methods and procedures	NA
Purpose of data	Baseline emission
Additional comment	NA

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/ MWh
Description	Combined margin emission factor of the grid
Source of data	Calculated as weighted average of Simple OM and BM
Value(s) applied	0.5736

Choice of data or Measurement methods and procedures	Calculated ex-ante as per “Tool to calculate the emission factor an electricity system” based on 50% of OM and 50% of BM values approach
Purpose of data	Baseline emission
Additional comment	NA

Data / Parameter	**Cap_{BL}**
Unit	W
Description	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data	Project site
Value(s) applied	0
Choice of data or Measurement methods and procedures	For new hydropower plants this value is zero
Purpose of data	Project emission
Additional comment	NA

Data / Parameter	**A_{BL}**
Unit	m²
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity when the reservoir is full (m²).
Source of data	Project site
Value(s) applied	0
Choice of data or Measurement methods and procedures	For new hydropower plants this value is zero
Purpose of data	Project emission
Additional comment	NA

Table 10 - Data and Parameters Fixed Ex-Ante

B.6.3. Ex ante calculation of emission reductions

Baseline emissions include only CO2 emissions from electricity generation by fossil fuel fired power plants that are displaced due to the project activity. It is calculated as follows:

EGy□□EGBL,y□□EFgrid,CM,y

Equation 9

Where:

EGy= Electricity supplied by the Nam Lik 1 Hydropower Project to the grid

$EG_{BL,y}$ = 248,600,000 KWh = 248,600 MWh

$EF_{grid,CM,y}$ = 0.5813 tCO2/MWh

Therefore,

therefore:

BE_y = 248,600 x 0.5813 = 144,519 tCO2/y

Project emissions

The project emission includes the two proponents of emission from backup power and a new reservoir.

The following formula is applied:

$$PE_y = PE_{FF,y} + PE_{HP,y}$$

Equation 10

PEFF,y is backup power emissions

PEHP,y is the emissions from the reservoir

The emissions from the reservoir (PEHP,y)

The proposed project activity involves the construction of a new hydropower plant with capacity (*CapPJ*) of 61.00 MW which will create a reservoir of 11.51km².

Emissions from the reservoir are calculated as follows :

$$PE_y = \frac{EF_{Res} \cdot TEG_y}{1000}$$

$$PE_y = \frac{(90\ Kg\ CO2e\ /MWh)*\ (248.6\ Gwh)}{1000}$$

PEy = 22,374 tCO_2

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)
2016	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2017	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2018	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2019	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2020	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2021	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
2022	144,519 tCO2/y	22,374 tCO2/y	0 tCO2/y	122,145 tCO2/y
Total	1,011,633 tCO2/y	156,618 tCO2/y	0 tCO2/y	855,015 tCO2/y
Total number of crediting years	7			
Annual average over the crediting period	122,145 tCO2/y			

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

All data to be monitored for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

Data / Parameter	TEG_y
Unit	MWh/yr
Description	Total Electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads in year *y*
Source of data	Direct measurement at the connection point
Value(s) applied	248,600
Measurement methods and procedures	Two-way power meters will be installed at the grid-connected point to measure the amount of electricity supplied to the grid by the proposed project by the positive direction. The readings of electricity meter will be hourly measured and monthly recorded. The recorded data will be confirmed by means of a joint balance sheet which will be signed by the representatives of EdL and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.
Monitoring frequency	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures	The uncertainty level of this data is low. The measurement/ monitoring equipment should be complied with national standard and technology. These equipment and systems should be calibrated and checked in accordance with the PPA
Purpose of data	Baseline emission
Additional comment	-

Data / Parameter	$EG_{facility,y}$
Unit	MWh/yr
Description	Electricity supplied by the grid to the proposed hydropower plant
Source of data	Direct measurement at the connection point
Value(s) applied	0
Measurement methods and procedures	Two-way power meters will be installed at the grid-connected point to measure the amount of electricity supplied to the grid by the proposed project by the positive direction. The readings of electricity meter will be hourly measured and monthly recorded. The recorded data will be confirmed by means of a joint balance sheet which will be signed by the representatives of EdL and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.
Monitoring frequency	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures	The uncertainty level of this data is low. The measurement/ monitoring equipment should be complied with national standard and technology. These equipment and systems should be calibrated and checked in accordance with the PPA
Purpose of data	Baseline emission
Additional comment	-

Data / Parameter	$EG_{BL,y}$
Unit	MWh
Description	Net electricity supplied to the grid by the proposed hydropower plant
Source of data	Calculated as the difference between $EG_{y, export}$ and $EG_{y, import}$
Value(s) applied	248,600
Measurement methods and procedures	Calculating by subtracting $EG_{y, import}$ from $EG_{y, export}$.
Monitoring frequency	Continuous monitoring, hourly measurement and at least monthly recording
QA/QC procedures	The uncertainty level of this data is low
Purpose of data	Baseline emission
Additional comment	-

Data / Parameter	Cap_{PJ}
Unit	W
Description	Installed capacity of the hydropower plant after the implementation of the project activity
Source of data	Project Site
Value(s) applied	61,000,000
Measurement methods and procedures	Manufacturer’s Nameplate
Monitoring frequency	Yearly
QA/QC procedures	-
Purpose of data	Project emission
Additional comment	-

Data / Parameter	$FC_{i,j\ y}$
Unit	Mass or volume unit per year (e.g. ton/yr or m_3/yr)
Description	The quantity of fuel type I combusted in process j during the year y in the event of black out of the plant
Source of data	Onsite Measurements
Value(s) applied	Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift)
Measurement methods and procedures	Continuously if backup system is in use
Monitoring frequency	Yearly
QA/QC procedures	The consistency of metered fuel consumption quantities should be crosschecked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Purpose of data	Project emission
Additional comment	-

Data / Parameter	A_{PJ}
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
Value(s) applied	11,510,000
Measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc
Monitoring frequency	Yearly
QA/QC procedures	-
Purpose of data	Project emission
Additional comment	-

Data / Parameter	$NCV_{i,y}$
Unit	GJ/mass or volume unit
Description	Net calorific value (energy content) of fuel type *i* in year *y*
Source of data	IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	Once each crediting period using the most recent three historical years for which data is available at the time of the submission of the CDM-PDD to the DOE for validation (ex-ante option)

QA/QC procedures	-
Purpose of data	Project emission
Additional comment	Gross calorific value (GCV) will be used

Data / Parameter	$\mathbf{EF_{CO2,i,y}}$
Unit	T CO2/GJ
Description	CO2 emission factor of fuel type *i* used in power plant m in year *y*
Source of data	2006 IPCC Default values
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	Once each crediting period using the most recent three historical years for which data is available at the time of the submission of the CDM-PDD to the DOE for validation (ex-ante option)
QA/QC procedures	-
Purpose of data	Project emission
Additional comment	If biofuels are used the value applied to the CO2 emission factor will be zero

Table 11 - Data and Parameters to be Monitored

B.7.2. Sampling plan

The data monitored will not be a sample but the actual data, therefore a sampling plan is not needed.

B.7.3. Other elements of monitoring plan

Because the baseline emission factor of Grid ($EF_{grid,CM,y}$) is fixed ex-ante (detail in Section B.6), the main data to be monitored is $EG_{BL,y}$. $EG_{BL,y}$will be calculated according to the formula below*:*

$EG_{BL,y,} = EG_{y,\ export} - EG_{y,\ import}$

The electricity generated from the project activity will be sold to EdL for the complete project lifetime.

The electricity generated from the project activity before entering into the grid at the grid interconnection point will be measured by a digital kilowatt hour (kWh) meter. The metering system includes the main system and a back-up system. The back-up system will be used in case of failing of the main meter.

Data from the operating meters will be recorded hourly. Additionally, monthly manual readings will be taken from the operating meters.

Monthly, EdL staff and staff of the operation division of the power plant will cross-check manual meter readings with the electronically recorded data and prepare and sign a joint balance sheet which indicates the amount of power fed into the grid within that month.

When the electricity generation from the plant is cut off, a backup generator with installed capacity of 250KVA to generate electricity will be used internally within the plant. In such case, the CDM team will keep all relevant records for verification purposes.

CDM Training will take the form of CDM Workshop to be held in Lao PDR in both English and Lao language. This training will be very specific to the Nam Lik 1 Project and will follow on from the Workshop held at EdL in Vientiane in November 2011.[8] This will take place initially during the construction period, and then as soon as practicable following Commissing. EdL is the local partner in this project and will play a major role in the operation of the plant.

CDM Training

The project owner will employ professional engineers and experts to train all staff before the operation of generators.

With regard to CDM training, specific CDM training will be provided by the CDM consultant as referred to above, and will take the form of workshops held for the relevant staff, and a CDM Monitoring manual.

Data Collection

The process of data collection will start on the date the Project commences its operations. The data measurement procedures, Quality Assurance and Quality Control procedures, person(s) responsible and frequency of monitoring are detailed in the Monitoring Table. 100% of the data are monitored at the site by means of accurately calibrated instruments and authentic procedures dedicated for the intended purposes.

The main electricity meter which measures the electricity delivered to the grid will be installed at Vangvieng substation. When taking electricity meter readings a detailed account of the meter, specific uncertainty levels and associated accuracy level of measurement instruments will be recorded. Data from the generation meter will be collected continuously. This information will be printed out. In addition to the automatic system an Operator based at the substation will manually record information in a log.

Monthly, all the electricity generation data will be incorporated into an electronic master sheet which would act as the electricity generation data archive. Data collection on the back-up meter (at Vangvieng Substation) will follow the same procedures as data collection on the revenue / generation meter outlined above.

The installed capacity of the Project and the area of the reservoir after the implementation of the Project activity will be monitored annually to monitor the power density of the Project.

Data records management procedure.

All information such as data records, maps and drawings, Environmental and Social Impact Assessment (ESIA) and Feasibility Study reports will be kept as records and made available to the verification party.

A documentation system (document register) will be developed to manage all the CDM documents and access all the records easily. All project related documents will be kept for the entire crediting period and two years thereafter. The CDM Manager has the overall responsibility for document maintenance and review. On a monthly basis, the CDM Manager will review all Project data, document registers and manage the data collection, storage and archiving of all relevant data records. The CDM Manager is responsible for preparing the annual CDM Monitoring Report.

Data Archiving

At the end of each month, all manually entered monitoring data will be filed electronically (e.g. spreadsheets) with paper or CD files as backup. The Project owner will keep all sales / billing

[8] Workshop Presentations

invoices and records and these will be archived both electronically and manually for the entire crediting period and two years thereafter.

Maintenance Procedures

All equipment will be inspected regularly for functionality, integrity and corrosion. Equipment will be maintained in accordance with manufacturer's instructions. Any defective components or materials shall be reported and replacements obtained and fitted within one day if there is a possibility of total failure, or otherwise within one week. The CDM Manager will retain all maintenance documents and a Maintenance Register will be implemented.

Training Procedures

The CDM Manager will manage the process of training new staff, and will ensure that trained staff performs their monitoring duties. Capacity building activities and training will be provided by EDL at the beginning of the Project construction and at the start of the operation to all Project related employees.

The training program will be delivered by external CDM specialists, and technical training by equipment suppliers. A Training Register will be implemented to keep track of all employee training and competence.

Quality Assurance / Quality Control (QA / QC) Procedures

Procedures for calibration of measurement equipments

All measurement equipment (fixed and portable) will be calibrated in accordance with relevant standards (national, international or industry standards). The electricity generation meters will be calibrated according to the IEC60521 or IEC61036 standards. A calibration record will be kept for every instrument irrespective of its frequency of usage and whether or not the equipment is an operational or spare unit. A Calibration Register will be maintained to keep track of all calibration records for the Project. The CDM Manager is responsible for organising the calibration and keeping all the calibration records.

Internal audit procedure

Internal audits will be undertaken to ensure all procedures are being adhered to and to confirm compliance with CDM rules and quality management. The internal audit will be carried out annually and no more than two months before each verification event. The CDM Manager is responsible for ensuring that the internal audits take place.

Error Handling, Corrective and Preventative Actions Procedure

Failure of monitoring equipment

In an event of main electricity meter failure, a backup meter shall be used in its place. If the backup meter fails, it will be replaced by an accredited equipment-testing organisation.

Error handling, corrective and preventative procedure

The CDM Manager will be notified of any errors found during internal audits. Specialists will be appointed to review the implications of the error and the proposed correction procedures. In case of emergency, the Project entity will not claim emission reductions due to the Project activity for the duration of the emergency. A procedure will be developed to outline the responsibility and authority for handling and investigating non-conformance, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive action. All non-conformances and special events reports will be recorded in a register. This register will be maintained by the CDM Manager and reviewed at the end of each crediting year.

B.7.4. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

07/11/2014

Responsible persons/ entities:

Mr. Philip Britton
Asianet Services Ltd.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

Four Year construction period and 25 year operation period. This is the concession period of the Build Operate and Transfer (BOT) project. The operational lifetime of the project is 25 years. The Project Developer will operate the hydropower plant for a 25 year concession period, after which it will be transferred to the Host Government

The start date is 17th October 2012

C.1.2. Expected operational lifetime of project activity

25 Years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

First crediting period of seven years to be renewed twice

C.2.2. Start date of crediting period

1st January 2016

C.2.3. Length of crediting period

Seven Years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

A full Environmental Impact Assessment Report and Environmental Monitoring Plan is available.

D.2. Environmental impact assessment

The study area of the Nam Lik 1 scheme (with its dam and reservoir) extends from the upper limits of the reservoir to downstream to the confluence with the Nam Ngum, and includes the reservoir, dam, river valley below the dam and lowland plains.

While there are direct environmental impacts associated with construction (e.g. habitat disturbance, dust, erosion, borrow and disposal problems), the greatest impacts result from the impoundment of water, flooding of land to form the reservoir, and alteration of the water flow characteristics downstream. These effects have direct impacts on soils, vegetation, wildlife, biodiversity and human settlement in the inundation area in the wider surrounds as detailed in the Impact Assessment (sections six through nine).

Potential Benefits to Local Communities

Many of the issues listed below tend to be negative impacts that can in most cases be mitigated and turned around to become positive influences in other areas. Other potential benefits from the development of the Nam Lik 1 Hydropower Project include:

Over time the reservoir represents recreational opportunities. Lao culture does not normally include many water sports other than boat racing, but the increasing influence of resident foreigners and tourists may encourage more recreational boating suited to the reservoir.

- Potential for reservoir fishery.
- Potential reduction of damaging flood peaks downstream
- A small reduction in the 1 in 10 000 year flood levels

Resettlement

The creation of the reservoir will displace 259 households. The resettlement site has not been identified but will be determined by a Resettlement Committee consisting of representatives from affected villages, local government and developers, on the basis of political, market access and agricultural production criteria. By Lao law, once implemented, the Resettlement Action Plan will ensure the resettled population will be at least as well off, or better, than they were prior to resettlement

The EIA and EMP provide an extensive list of mitigation measures that are to be required of the contractors during construction of the project, and describes the management and monitoring programs required to ensure potential impacts are minimized to the maximum extent possible.

The Nam Lik 1 project has a relatively small reservoir and will be operated as a run of the river project. Because of this, if the proposed mitigation management and monitoring measures and plans are implemented as described, it is expected that the project will generate very few significant residual environmental and social impacts.

Detail survey to collect commercial tree species before clearing and commencement of construction is recommended particularly within the dam site and along the proposed access road and proposed transmission line from powerhouse to Ban Don Sub-station.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

Local community participation in planning, implementation and monitoring is a key element in hydropower projects. Involvement of stakeholders on the local level aims to ensure that benefits reach these populations and that construction and operation of the project progress smoothly without delays or resentment from the affected communities. For local participation to work, a feedback loop' must be established to show that the opinions, concerns and expectations of people have been seriously considered and when feasible incorporated into the design of the project. The most important steps are as follows:

- Information dissemination to affected communities - this has commenced in Stage I and will continue as more details and proposed mitigation measures are developed
- Interactive Planning is when draft mitigation measures and proposed site selection and livelihood restoration have been developed based on data collection, technical specification and initial feedback from discussions at the village and regional levels. This is primarily Stage 2 of the consultation process but will continue throughout implementation.
- Participatory Implementation and Monitoring implies that the affected communities themselves will have a central role in organizing and carrying out mitigation measures, including relocation and rehabilitation of livelihood systems. This is primarily Stage 3 of the process.

This approach aims to avoid the problem of `consultation fatigue' that can be a problem for large infrastructure projects that take considerable time in the planning stage. For the writing of this RAP/SIA, small meetings and focal discussion groups have been held. This is to avoid creating unrealistic expectations about the project. It has been agreed with GOL authorities that it would be wise only to carry out large-scale consultations using PRA methods only after the project has been considered technically and economically feasible.

Consultations should be `informed' discussions when the facts and technical limitations are known, especially regarding resettlement, which involves a complex process of relocation and restoration and improvement of livelihood systems. It is very important to be consistent in presenting such impacts to affected communities since incorrect information will cause considerable confusion and worry.

Disclosure of Information
Disclosure Principles

In accordance with National Policy on Sustainable Hydropower Development, the disclosure of information to project stakeholders and the general public is necessary. This implies that reliable and up-to-date information on the project as it develops should be available through various media. The main aspects include:

- Use of Lao TV and radio to reach the general pubic - updates about progress on the project and public meeting announcements.

- Information bulletins to national and international newspapers and information to visiting journalists or international NGOs

- Summaries and explanations of the project in all affected communities and information Centres where reports are available.

- Translation of all major report summaries into Lao with the final RAP to facilitate GOL involvement and understanding where necessary and National workshops open to all interested parties and the general public and website information to be posted regularly.

Project Information centre

In Stage 2 (Detailed Planning) a number of steps will be taken to ensure that information about the project will be made available to the affected communities and the general public:

- Posters, diagrams and short, easy-to-read explanations of the project features, impacts and proposed mitigation are to be set up in all affected villages as part of Stage 2 Local Consultations.
- An information centre will be established in Hinheup District HQ with posters, diagrams and explanations of the project, its impacts and proposed mitigation. In addition, copies of the latest approved versions of reports in English and summaries in Lao will be available to the general public.
- An information centre will be established at the Provincial Capital HQ at Office of Water Resource and Environment with posters, diagrams and explanations of the project, its impacts and proposed mitigation. Copies of the latest approved versions of reports in English and summaries in Lao will be available to the general public.
- An information centre will be established in Vientiane Capital with the same information and reports as mentioned in the other centres. This centre could be part of a project office where additional information could be made available to journalists and specialists.

Web Page Information

In order to reach a wider international audience, the creation of a website should be considered. The website could contain the following information:

- Description of the project.
- Latest approved report summaries.
- Links to project coverage by various media.
- Discussions by various interested parties or links to other websites following the development of the project.

E.2. Summary of comments received

Key Participants and Main Issues for Discussion

Meetings were held in July 2007

Key participants to the consultations were mostly included chiefs of village, representatives from village mass organizations including Lao women Union in each village, village elderly, village Youth and affected villagers. The number of participants and other details are shown in the Table in the EIA Report.

Outline of the Project as well as topography map and land use map were shown and explained to the villagers and village authorities concerned. The expected project area as well as project study areas which expected to be affected both direct and indirect by the project especially land use types that expected to be inundated have been discussed.

Brochures on briefing of the project were distribute and explained.

Since the impacts and affected land by the Project will be minimal, all of participants basically agreed the implementation of the Project with few comments. They expressed their willingness to participate in the construction work of the Project as labors to get income from the Project. Only in some villages, participants mentioned that proper compensation for affected land should be ensured.

E.3. Report on consideration of comments received

Following meetings with stakeholders, the following action plan was agreed. More details are included in the EIA Report.

Environmental Resources and Values	Construction phase	Operation phase
Air quality	• Assess the incinerator • Spray water	• Dust control
Noise	• Minimize working at night within this area • Inform people of possible damage from vibration before using Vibrating Rollers near to settled area.	• Increased traffic volumes vehicle speed
Surface water quality	• Assess and establish of the waste water treatment plant	• Operation of the waste water treatment plant
Socio-economics	• Staff for training	• Survey of socioeconomics condition of community around the project
Public health	• Networking with hospitals	• Operate the factory healthcare center • Improve networking with hospitals
Occupational Health and Safety	• Networking with fire fighting unit • Regular inspection of machinery	Inspect incoming and outgoing people in project road area
Solid Waste Management	Assess the solid waste management (discussion with Phonhong District and implement the management plan)	Implement the management plan
Physical and Forest resources	Conclude the land lease agreement Review the design Prepare and implement the greening plan for the road construction area	Maintenance of the green area Collaboration with the DAFO
Transportation	Comply to the Regulations and laws	Comply to the Regulations and laws

Further Stakeholder Consultation Meetings were held in 2008 and 2009, in addition to CDM Meetings in 2011.

SECTION F. Approval and authorization

The Letter of Approval from the Host Country DNA was submitted to the DOE

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

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Hydro Engineering Co. Ltd.
Street/P.O. Box	
Building	238/22 Ratchadaphisek Road
City	Huay Kwang, Bangkok
State/Region	
Postcode	10310
Country	Thailand
Telephone	+6622741909
Fax	+6622741705
E-mail	hydroeng@truemail.co.th
Website	
Contact person	
Title	Managing Director
Salutation	Ms.
Last name	Hongkajorn
Middle name	
First name	Chinda
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Project participant and/or responsible person/ entity	☐ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Asianet Services Ltd.
Street/P.O. Box	
Building	59/199 Moo 16, British Town, Srinakarin Road
City	Bangkaew, Bangplee
State/Region	Samutprakarn
Postcode	10540
Country	Thailand
Telephone	+6627588482
Fax	+6627588480
E-mail	philip@airb.net
Website	
Contact person	
Title	Chief Executive Officer
Salutation	Mr.
Last name	Britton
Middle name	
First name	Philip
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Appendix 2. Affirmation regarding public funding

No Public Funding is foreseen for this project.

Appendix 3. Applicability of methodology and standardized baseline

The baseline and monitoring methodology ACM0002 Version 15.0.0 is applicable to the proposed project, because the project meets all the applicability criteria stated in the methodology:

Condition: The project activity is the installation or modification/retrofit of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit.

Project: The proposed project is a grid-connected hydropower generation project. Thus the project is in compliance with this applicability condition.

Condition: In case of hydro power plants:

- The project activity is implemented in an existing reservoir, with no change in the hose volume of reservoir.
- The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m2.
- The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m2.

Project: The project will create a new reservoir with a power density greater than 4 W/m2 (see also section B.3.). Thus the project is in compliance with this applicability condition.

The methodology ACM0002 (Version 15.0.0) is applicable to the proposed project, because the proposed project meets all the applicability criteria stated in the methodology:

Condition: The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

Project: The geographic and system boundaries for the relevant electricity grid, the Lao Southern Grid and the Thai Grid, can be clearly identified and information on the characteristics of the grid is available.

The methodology includes two conditions that are not relevant to the proposed project activity:

Condition: Applies to grid connected electricity generation from landfill gas to the extent that it is combined with the approved "Consolidated baseline methodology for landfill gas project activities" (ACM0001).

Project: The project does not involve the generation of electricity from landfill gas and therefore this condition is not applicable.

Condition: 5 years of historical data (or 3 years in the case of non hydro project activities) have to be available for those project activities where modification/retrofit measures are implemented in an existing power plant.

Project: The project does not involve a modification/retrofit and therefore this condition is not applicable.

The methodology furthermore includes a number of disqualifying conditions, as indicated below:

Condition: The methodology is not applicable to project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site.

Project: The project does not involve an on-site switch from fossil fuels to a renewable source.

Condition: The methodology is not applicable to biomass fired power plants.

Project: The project is a hydropower plant and does not involve the firing of biomass.

Condition: The methodology is not applicable to hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is lower less than 4 W/m2.

Project: The power density of the project is greater than 4 W/m2

The methodology will be used in conjunction with the approved consolidated monitoring methodology ACM0002 (Consolidated monitoring methodology for grid-connected electricity generation from renewable sources). The latest version of ACM0002 (Version 15.0.0) has been applied.

• The project activity results in new reservoirs and the power density of the power plant, is greater than 4 W/m^2. The total installed capacity of the proposed project is 61.00 MW; the surface area at full reservoir level is 11.51 KM2,

• The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

• Project activitiy does not involve switching from fossil fuels to renewable energy sources at the site of the project activity,

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

The following emission factor calculation refers to the "Study of Emissions Factor for an Electricity System in Thailand 2009" which was published by the Thailand Greenhouse gas Office (TGO) in 2010. Further source data used was the Electricte du Laos Annual Reports from 2007, 2008 and 2009.

The combined margin emission factor (EFgrid,CM,y) is calculated as per methodological tool "Tool to calculate the emission factor an electricity system" version 04, consisting of the combination of operating margin (OM) and build margin (BM) emission factors as shown in the following steps:

Step 1: Calculate the Operating Margin emission factor(s) ($EF_{grid,OM,y}$)

The operating margin is based on the Simple OM emission factor ($EF_{grid,OMsimple,y}$), which is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system (option C), not including low-operating cost and must-run power plants as follows:

Section 1.01

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \ x \ NCV_{i,y} \ x \ EF_{CO2,i,y}}{EG_y}$$

Where:

$EF_{grid,OMsimple,y}$ = Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)

$FC_{i,y}$ = Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)

$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type *i* in year (GJ/ mass or volume unit)

$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel *i* in year y (tCO_2/ GJ)

EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/ must run power plants/ units, in year *y* (MWh)

i = All fossil fuel types combusted in power sources in the project electricity system in year *y*

y = either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ant option).

By using the default value from Revised 2006 IPCC Guideline for National Greenhouse Gas Inventories, the CO_2 emission coefficient of each fuel type is demonstrated in Table 3. The default oxidation factor is assumed to be one.

Fuel Type	Net Calorific Value[1] (NCV)		CO_2 emission coefficient[2] ($COEF_i$)		
	MJ/Unit	Unit	tCO_2/TJ	tCO_2/Unit	Unit
Natural gas	1.02	MMscf	56.10	57.22	MMscf
Fuel oil	39.77	million litres	77.40	3,078.20	million litres
Diesel oil	36.42	million litres	74.10	2,698.72	million litres
Lignite	10.47	kg	101.00	1,057.47	k tonnes
Imported coal	26.37	kg	94.60	2,494.60	k tonnes

[1] Study of Emissions Factor for an Electricity System in Thailand 2009. Also note that the value of Lignite is based on Mae Moh site.

[2] Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.3 p. 2.18 - 2.19

Table 12 Emission Coefficients

Table 12 shows the CO_2 emission from each fuel type generated from the national grid system during 2005-2007. According to the methodological tool, imported electricity should be included in the calculation with zero tCO_2/MWh. The results in the table below show that the 3-year average OM emission factor is 0.59939 tCO_2/MWh

Fuel Type	Fuel Consumption		CO2 Emissions (kgCO2/Unit)	CO2 Emissions (kgO2)
	Unit	Volume		
2009				
Total				82,192,233
Natural Gas	scf.	968,924,717,809	0.0554	53,678,429
Lignite	ton	15,818,265	951.7230	15,054,607
Bituminous	ton	5,486,248	2,360.1150	12,948,176
Bunker	litre	158,017,445	3.0026	474,463
Diesel	litre	13,825,937	2.6441	36,557
Fuel Type	Fuel Consumption		CO2 Emissions (kgCO2/Unit)	CO2 Emissions (kgO2)
	Unit	Volume		
2008				
Total				84,097,036
Natural Gas	scf.	977,016,893,281	0.0554	54,126,736
Lignite	ton	16,407,465	951.7230	15,615,362
Bituminous	ton	5,578,567	2,360.1150	13,166,060
Bunker	litre	350,209,394	3.0026	1,051,539
Diesel	litre	51,941,958	2.6441	137,340
Fuel Type	Fuel Consumption		CO2 Emissions (kgCO2/Unit)	CO2 Emissions (kgO2)
	Unit	Volume		
2007				
Total				83,513,708
Natural Gas	scf.	942,438,130,658	0.0554	52,211,072
Lignite	ton	16,060,766	951.7230	15,285,400
Bituminous	ton	5,582,847	2,360.1150	13,176,161
Bunker	litre	936,221,005	3.0026	2,811,097
Diesel	litre	11,337,184	2.6441	29,977

Table 13 - CO2 Emissions 2007 - 2009

Year	CO2 Emissions (tCO2)	Grid Comsumption (GWh)	OM Emission Factor	
			tCO2/MWh)	gCO2/kWh)
2009	82,192,233	136,193.80	0.60349	603.49
2008	84,097,036	136,116.14	0.61783	617.83
2007	83,513,708	133,981.76	0.62332	623.32
Summary	249,802,975.96	406,291.70	0.61484	614.84

Step 2: Calculate the Build Margin emission factor ($EF_{grid,BM,y}$)

The build Margin emission factor is calculated as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants *m*, as follows:

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

Where:
$EF_{grid,BM,y}$ = Buid margin CO2 emission factor in year *y* (tCO_2/ MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of powr unit *m* in year y (tCO_2/ MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year y (MWh)
m = Power units in the build margin

Power Consumption by the Most Recently Built Power Plants		
Power Unit	**Grid Generation (GWh)**	**COD**
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	8,153.26	1/7/2008
Gulf Power Generation Co. Ltd. (Unit 1&2)	9,338.68	1/3/2008
BLCP Power Co. Ltd. (Unit 1&2)	10,018.13	1/2/2007
Summary	38,323.76	
As percentage of 2009 Grid Generation	26.38%	

Fuel Type	Fuel Consumption		CO2 Emissions (kgCO2/Unit)	CO2 Emissions (tCO2)
	Unit	Volume		
Total				20,994,819
Natural Gas	scf.	223,467,679,056	0.0554	12,380,109
Lignite	ton	-	951.7230	-
Bituminous	ton	3,645,721	2,360.1150	8,604,321
Bunker	litre	-	3.0026	-
Diesel	litre	3,929,038	2.6441	10,389

Build Margin 0.5478 t CO2 / MWh

Step 3: Calculate the baseline emission factor

The Combined Margin emission factor is calculated as the weighted average of the Operating Margin emission factor ($EF_{grid,OM,y}$) and the Build Margin emission factor ($EF_{grid,BM,y}$) as follows:

$$\mathbf{EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM}}$$

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

The default values of w_{OM} and w_{BM} for hydropower generation project are 50% and 50% respectively as stated in the tool. The CM emission factor is calculated as shown in the equation above:

	Weight	Emission Factor
Operating margin	0.50	0.6148
Build margin	0.50	0.5478
Baseline (Combined margin)		**0.5813**

Baseline emissions

$$BE_y = EF_{grid,CM,y} * EG_{PJ,y}$$
$$= EF_{grid,CM,y} * EG_{facility,y}$$

Where:

BE_y = Baseline emission for year y, tCO_2/ year

$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the “Tool to calculate the emission factor for an electricity system” (tCO_2/MWh)

$EG_{PJ,y}$ = Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)

$EG_{facility,y}$ = Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/yr)

Combined margin emission factor (tCO_2/MWh)	0.5813
Electricity generation (MWh)	248,600
Baseline emission (tCO_2/ year)	144,519
Total baseline emission (tCO_2/ year)	**144,519**

Step 4: Emission Reductions

Since there are no anthropogenic emissions by sources of GHG due to the project activity, the emission reduction will be equal to the baseline emission.

ER_y = BEy- PEy

Where:

ER_y = Emission reductions generated in year y, tCO_2e/yr

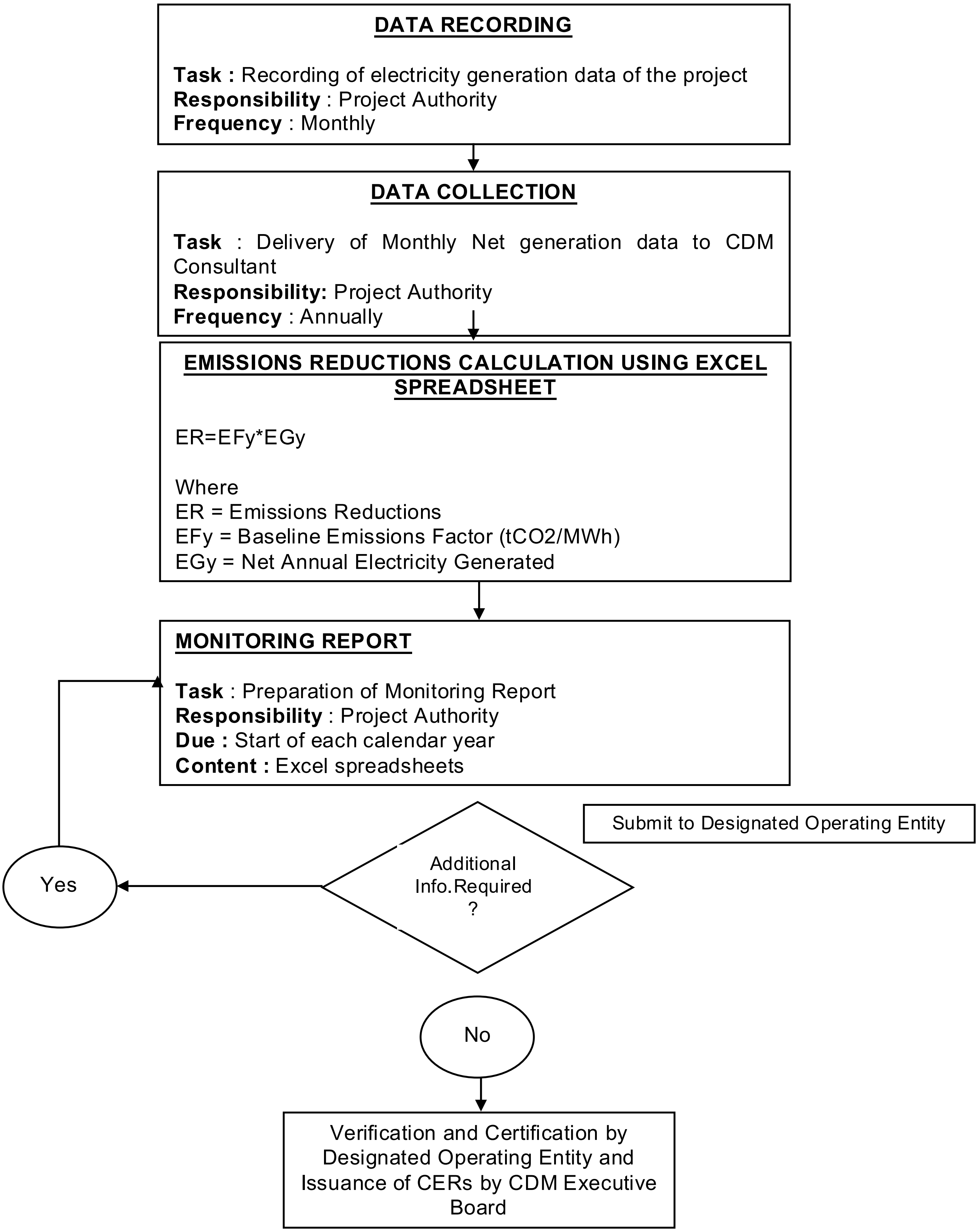
BE_y = Baseline emissions in year y, tCO_2e/yr

PEy = Project emissions in year y, tCO2e yr

Year	Estimation of annual emission reductions (tCO_2e)		
	Baseline Emissions	Project Emissions	Total
2016	144,519	22,374	122,145
2017	144,519	22,374	122,145
2018	144,519	22,374	122,145
2019	144,519	22,374	122,145
2020	144,519	22,374	122,145
2021	144,519	22,374	122,145
2022	144,519	22,374	122,145
Total number of crediting years	7		
Estimated reductions (tonnes of CO_2e)	**1,011,634**	**156,618**	**855,016**
Total estimated reductions (tCO_2e)	**855,016**		
Annual average of the estimated reductions over the crediting period (tCO_2e)	**122,145**		

The ex ante estimation of emission reductions

Appendix 5. Further background information on monitoring plan



Appendix 6. Summary of post registration changes

The project is under the process of submitting the PDD to the validating DOE

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Document information

Version	*Date*	*Description*
05.0	25 June 2014	Revisions 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;* • 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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