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 Sana Hydropower Project
Version number of the PDD	07
Completion date of the PDD	24th December 2014
Project participant(s)	Electricité du Laos, Lao PDR Eneco Energy Trade, B.V., Netherlands
Host Party	Lao PDR
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Scope Number 1 – Energy industries (renewable), hydropower Methodology – AMS I.D. Version 17
Estimated amount of annual average GHG emission reductions	25,335 tCO2e per annum

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

Nam Sana is located in a tributary of Nam Lik River, near M. Kasi and in the North of Vientiane Province, central Lao PDR. The potential site is proposed where it can control a catchment of about 96 km^2.

The Nam Sana Project is characterized as a run-of-project and medium head of about 160 m. Its head developed by a quite long waterway of about 3-4 km long depend on the route. The power waterway of the project consists of low pressure headrace box culvert and high pressure penstock. Between the two sections, a surge tank will be provided in order to reduce the effect of water hammer from sudden operation of gate closing and opening. Two options for the waterway i.e. long headrace box with short penstock and short headrace box and long penstock were studied. The options arise due to the steep slope of the mountain along the last section of headrace of about 1.3 km long before reaching a surge tank. It is foreseen that constructing the long headrace box culvert following the contour line from the intake to the surge tank will face the problem of a huge rock excavation work and will not be economical for the project. So, the scheme comes up with the option of short headrace box culvert and long penstock..

An installed capacity of 14 MW could be developed with the generated power supplied to the Central Laos Grid which is connected to the Thai National Grid.

The proposed project will result in CO_2 emission reduction, as it will displace the power generation that otherwise would be based on a mix of fossil fuels. The reduction in carbon dioxide emissions is estimated to be 25,335 tonnes per year.

The overall purpose of the project is the generation of electricity based on renewable energy sources. The electricity will be delivered to the grid. 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 CO2 emissions in the 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.

A map of the Project Area is shown below.

Figure 1 - Project Location

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.

Muang Kasi, Phong Ngam District

A.2.4. Physical/Geographical location

The geographical co-ordinates for the project are as follows :

Dam Location

Latitude - 19.216038°N
Longitude –102.339227° E

Power House Location
Latitude – 19.204662° N
Longitude –102.310886° E

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 hydro 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 Nam Sana Hydropower Project has been planned to meet the following objectives;

1) To increase the electrification ratio in the southern region,
2) To reduce power import from neighboring countries in the dry season,
3) To increase power export to neighboring countries in the wet season.

The main features of the project are detailed in the table below[1].

Item		Main Features
Hydrology	Catchment Area	96 km²
	Reservoir Inflow	5.96 m3/s
Output	Installed Capacity	14 MW
	Annual Generated Energy	49.55 GWh/y
Reservoir	Run of River Project	-
Dam / Headrace and Penstock	Weir Height	7m
	Full Surface Level	642 masl
	Headrace Tunnel	966m
	Pemstock	1,424 m
	Number of Units	3
	Turbine Type	Francis
	Turbine Discharge	11.50 m3/s
	Average net Head	145 m
Transmission	Line Length	17 km
	Voltage	22.00 kV

Table 1 - Main Technical Features

The main project component consists of

Weir

The weir of the Nam Sana project closes the valley with the length of 29.5 m. The weir crest elevation is at +642.00 m MSL, and the downstream slope is a steep slope of 1:0.7 (V: H). At the right abutment, an intake structure is to be located at right bank as a part of weir structure. The intake will be modified to plug or incorporated to bottom outlet by creating the new entrance and conveyance appurtenance structures during the final phase of construction. The spillway design flood is selected

[1] Feasibility Study – Executive Summary Page 3

with a return period of 1,000 years with peak flood discharge 453.0 m3/s. The spillway of ungated type is designed as an ogee crest; the stilling basin will be constructed to convey flows and hydraulic dispersion.

Headrace Box Culvert

The headrace box culvert shall be designed as a concrete structure which the total length and size of tunnel are 966.5 meters 2.5 x 2.5 meters respectively. The headrace box culvert must be designed to resist the internal water pressure about 1,800 kg/m^2 . As the power intake, the headrace box culvert is designed for maximum discharge of 11 .56 m3 /second (for operation)

Surge Tank

A surge tank is designed to protect the headrace box culvert and penstock to subject to the pressure rise due to water hammer and also function as the water storage facility for supplying water to the turbine for the case of suddenly load demand.

Powerhouse

The surface powerhouse of Nam Sana will be made of simple reinforced concrete, designed to accommodate 4 MW@ 2 units of turbine and generator and 6 MW @ 1 unit of turbine and generator ; totally l4 MW. The powerhouse will be located on the right bank of Nam Sana River.

Tailrace Channel

The project needs a tailrace channel for releasing the generation water from the powerhouse to the natural stream in this case Nam Sana downstream of the powerhouse. It will be designed according to the design discharge of about 11.56 m3/s. An open channel type is foreseen due to the terrain along the route of the channel. According to the development plan, it needs about 650 m long of tailrace channel, it will be designed as open channel type.

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 PDR (host)	Electricite du Laos, Lao PDR	No
United Kingdom	Eneco Energy Trade, B.V., Netherlands	No

A.5. Public funding of project activity

No public funding is foreseen for the implementation of the Nam Sana 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 AMS I.D. baseline methodology for grid-connected electricity generation from renewable sources, Version 17, Scope 1, EB 61.

Methodological tool "Tool to calculate the emission factor for an electricity system", version 04.0, EB 75.

Methodological tool "Tool for the demonstration and Assessment of Additionality" version 0.7.0.0, EB 70.

B.2. Applicability of methodology and standardized baseline

The methodology is applicable under the following conditions:

This methodology is applicable to project activities that (a) install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).

The methodology is applicable as the proposed project is a new-built renewable energy generation project (hydroelectric) that supplies electricity to the Central Lao Grid, which is a regional grid (project activity (a)).

Table 3.Applicability of small scale methodology AMS-I.D.

	Criteria	Applicability	Comment
1	This category comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity to a national or a regional grid.	Applicable. The proposed project activity is the installation of hydropower plant that supplies electricity to a regional grid.	OK
2	Illustration of respective situations under which each of the methodology (i.e. AMS-I.D,) applies is included	Project supplies electricity to a regional grid.	OK
3	Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or • 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	Not applicable. The proposed project activity is a run-of-river hydropower project with no reservoir.	OK

	the Project Emissions section, is greater than 4W/m2; or • 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.		
4	If the new unit has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit cofires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	Not applicable. The proposed project activity is a hydropower plant without any non-renewable components.	OK
5	In the case of biomass power plants, no other biomass types than renewable biomass are to be used in the project plant	Not Applicable. The proposed project activity is a hydropower plant	OK
6	Combined heat and power (cogeneration) systems are not eligible under this category	Not Applicable. The proposed project activity is a hydropower plant	OK
7	In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units	Not Applicable. The proposed project activity is a hydropower plant	OK
8	In the case of retrofit or replacement, to qualify as a small scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW	Not Applicable. The proposed project is green field project, with the total installed capacity to be 14 MW	OK

From the analysis above, AMS I.D. (Version 17.0) is applicable for the proposed project.

The project is not a debundled part of a larger project for the following reasons :

- There is no registered small-scale CDM project activity or any application to register another CDM small-scale CDM project activity by the project participant, i.e. Eneco or EdL within the past two years in respect of the same project category and technology within 1 km of the project boundary of the project activity.
- The project is located in a remote rural region and there is also no hydropower plant within 1 km of the project area.

B.3. Project boundary

According to methodology AMS I.D, version 17 the boundary for this project type is delineated by:

• Geographical site: the area where the project is constructed which includes the dam, the tunnel, the power house and the sub-station.

• Physical boundary: This consists of all power plants connected physically to the electricity system, which is defined as the Lao Central C1 Grid and the EGAT Grid in Thailand, to which the project is connected.

The Project Boundary is shown in the diagram below.

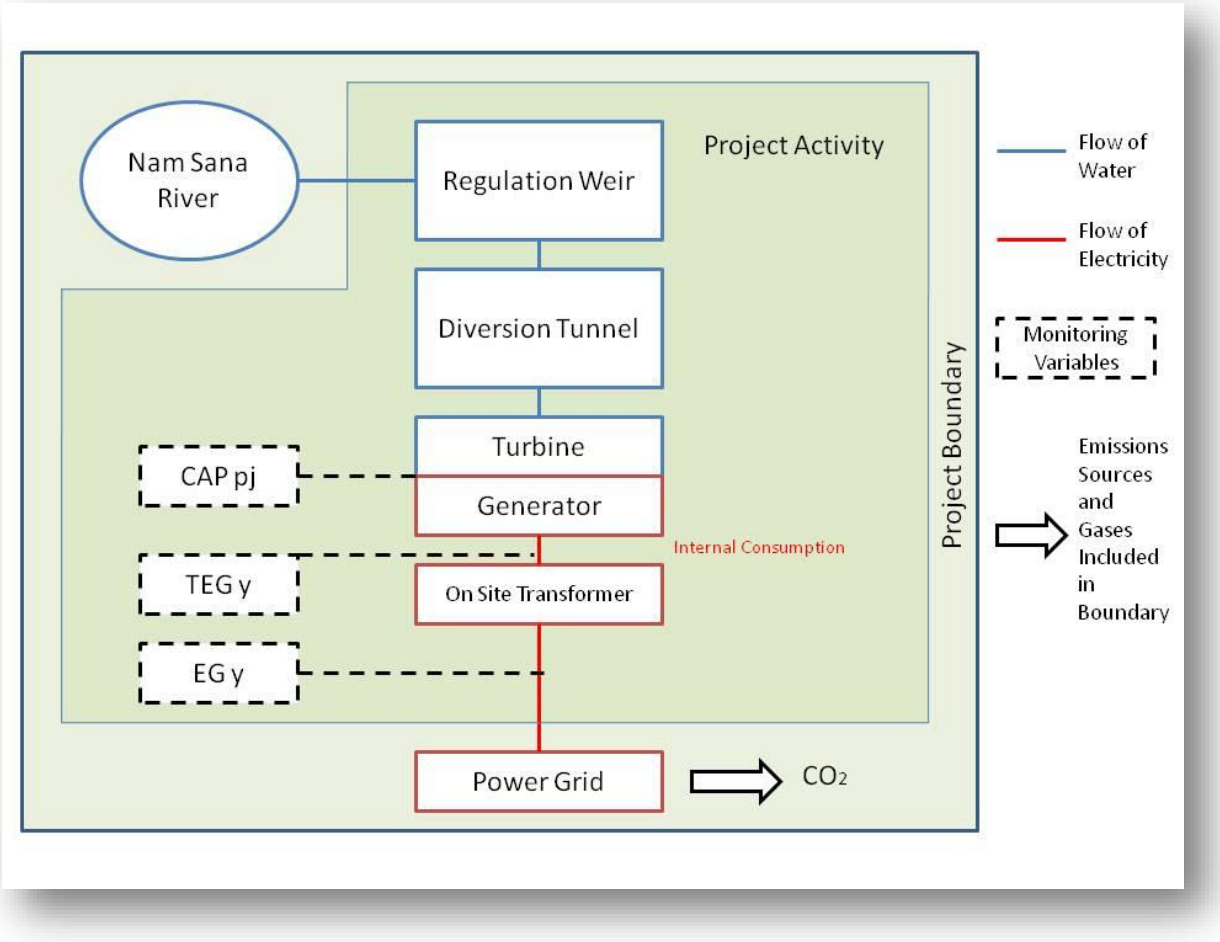

Figure 2- Project Activity and Project Boundary

The Lao Grid is connected to the Thai Grid, as shown in the map below.

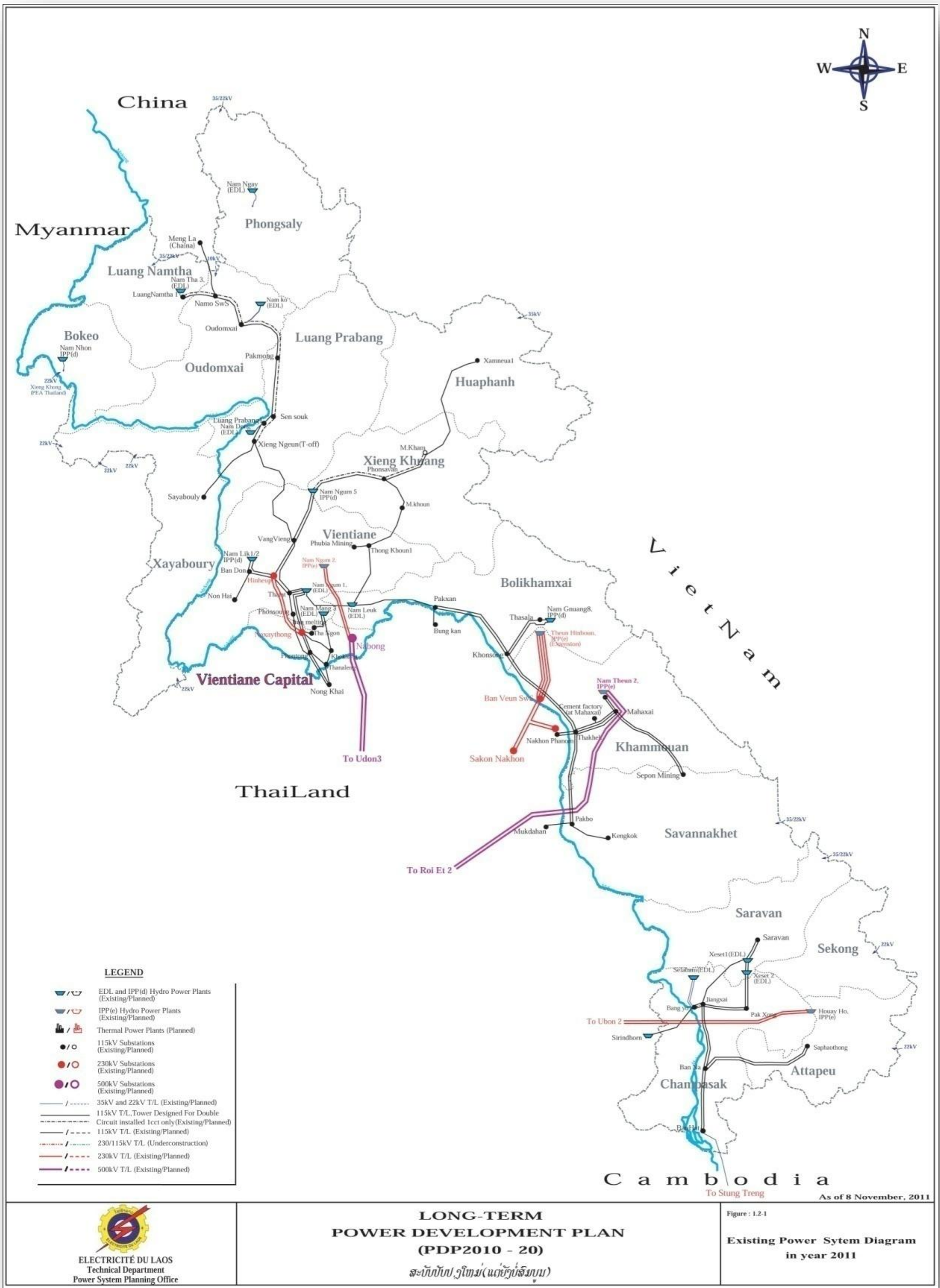

Figure 3 - Lao Grid and Connections to the Thai Grid

The GHGs and emission sources included in the project boundary are shown in the table below.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	CO_2 emissions from electricity generation in fossil duel fired power plants that is displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project scenario	For hydro power plants, emissions of CH_4 from the Reservoir	CO_2	No	Minor emission source
		CH_4	No	Run of river power plant so there is no reservoir created. As such that these emissions can be disregarded.
		N_2O	No	Minor emission source
	CO2 emissions from back up power generation	CO_2	Yes	Main emission source. The volume of emission is estimated based on the operation hours of the backup system, and the volume and type of fossil fuel consumed by the backup system in year y. The accurate emission is monitored and calculated in year y.
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

B.4. Establishment and description of baseline scenario

Because the project activity is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources.

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

$$BE_y = EG_{BL,y} \times EF_{CO2,grid,y}$$

Where:

BEy Baseline Emissions in year y;(tCO2)

EGBL, y Quantity of net electricity supplied to the grid as a result of the implementationof the CDM project activity in year y (MWh)

EFCO2,grid,y CO2 emission factor of the grid in year y (tCO2/kWh)

The Emission Factor can be calculated in a transparent and conservative manner as follows:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the emission factor for an electricity system'.

OR

(b) The weighted average emissions (in tCO2e/kWh) of the current generation mix. The data of the year in which project generation occurs must be used

Method (a) is used for calculation of the emission factor.

The Nam Sana project will connect to the Lao Central C1 Grid which is connected to Thailand.

The Thai national electricity grid, which is operated and monopolized by the EGAT and is the unique transmission and distribution line, to which all power plants in Thailand are physically connected to is the project electricity system. This forms the baseline scenario of the project.

Thus the baseline scenario of the proposed project is the delivery of equivalent amount of annual power output from the Thai national grid, to which the proposed project is connected, and the power generated in Lao PDR and distributed via the interconnected grid.

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[2], 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.

Since 1971, there have been regular power exchanges and interconnections between Lao PDR and Thailand. Currently there are 9 such interconnecting lines situated along the border of Lao PDR and Thailand for import and export purposes (see, Figure 4). Historical import and export data for Lao PDR and neighbouring countries including Thailand is also available (see Annex 3).

The Nam Sana Project will be connected to the Central Supply Area of Lao PDR, which forms an integral part and extension of the EGAT Grid System (see Figure 5). The Central Supply Area is isolated from all other electricity supply areas in Lao PDR and is connected only to the EGAT Grid System (see Figure 6). Regular exchanges between Lao PDR and Thailand occur without any transmission constraints and according to the blanket Power Purchase Agreement (PPA) between Electricite Du Laos (EDL) and EGAT, EDL can freely import surplus energy without committing to the quantity or timing of either.

The interconnection points on the grid are shown in the figures below.

[2] AMS I.D. makes reference to ACM0002 and the relevant Tool to Calculate the Emissions Factor of an Electricity System

Figure 4 - Map of Individual Grids in Lao PDR

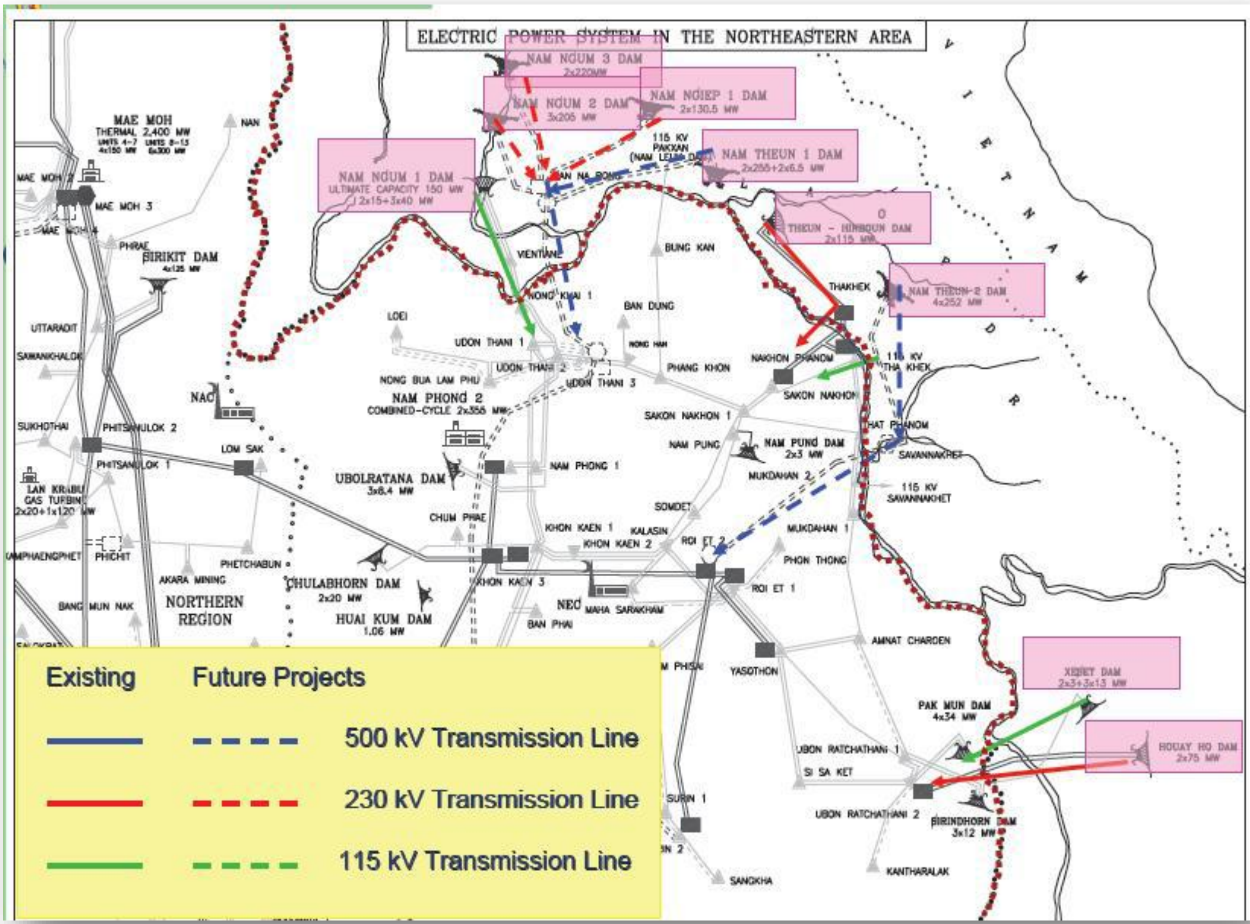

Figure 5 - Connection Points Between Lao PDR and Thailand

Following the EB guidance on the consideration of national and/or sectoral policies and circumstances in
baseline scenarios (EB 22, annex 3), two types of policies E+ and E- have been examined.

(a) National and/or sectoral policies or regulations that give comparative advantages to more emissions intensive technologies or fuels over less emissions-intensive technologies or fuels. To date, the governments of Thailand and Laos have not implemented any such E+ policies that are available and/or to be accessed publicly.

(b) National and/or sectoral policies or regulations that give comparative advantages to less emissions intensive technologies over more emissions-intensive technologies (e.g. public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs):

the latest relevant policy is the

–National Master Plan on national power development for the period 2006-2015 perspective to 2025 (Master plan VI) approved by the Prime Minister in 2007. According to EB 22, annex 3, it is not needed be taken into account in developing a baseline scenario as it is implemented after 11 November 2001. Furthermore, the main power capacity additions (new power plants) set out in the Master Plan are fossil fuel fired power plants. There are no special incentives for less emission intensive technologies.

So, the baseline scenario of this proposed project refers to a hypothetical situation or the delivery of equivalent amount of annual power output from the Thai and Lao national grid.

B.5. Demonstration of additionality

The Project Owner was aware of CDM incentives following the completion of the Feasibility Report.

As the initial Feasibility Studies started to show that the Project had some potential, but would be marginal for investors, the Project Owner started to obtain quotations from CDM Consultants. The first such quotation was received in January 2011.

CDM consultants were appointed but the CDM development had to wait until the social and environmental reports on the project were formally approved by GOL. CDM activity commenced prior to the final signing of the relevant approvals as these approvals had been given in principle but had to wait for a meeting of the Cabinet for the formal approval.

Major Milestones in the Development of the Investment Project and CDM Application

Detail	Date	Document
Feasibility Study Report Completed	November 2010	Feasibility Study
CDM Revenues referred to in EdL IPO prospectus	November 2010	Specific reference to CDM revenues in the IPO Prospectus[3]
CDM Consultant Proposal Requested	January 2011	Presentation and Meetings in Vientiane[4]
CDM Consultant Proposal Agreed	28th July 2011	E-Mail from EdL to Consultant[5]
CDM Consultant Contract Signed	September 2011	CDM Consulting Contract [6]
CDM Revenues referred to in IEE Report	August 2011	The FINAL report was prepared in December 2011 and submitted for Approval by the Government of Laos.[7]
CDM Consultant Contract Signed	September 2011	CDM Contract Addendum Signed 27th January 2012[8]
DNAs Notified of CDM Project	9th March 2012	Letters from DNAs[9]
UNFCCC EB Notified of CDM Project	15th March 2012	UNFCCC Website
Bids sought from Buyers	March 2012	Project Idea Note[10]
Bid Recommendations sent to EdL	9th March 2012	Letter to EdL[11]
Termsheet signed with Buyer	9th May 2012	Signed Termsheet[12]

[3] IPO Prospectus Page 11

[4] Powerpoint Presentations

[5] Copy Available

[6] Copy Available

[7] Feasibility Study Section 3.7

[8] Copy Available

[9] Acknowledgement of Receipt from WREA

[10] Copy Available

[11] Bid Summary and Recommendation Document Available

[12] Copy Available

Social and Environmental Assessment Reports Approved	21st May 2012	See Letter from Government of Lao PDR and Translation[13]
Feasibility Study Report Approved by GOL	21st May 2012	Letter from The Government of Laos (GOL)[14]
ERPA signed with Buyer	8th August 2012	Signed ERPA[15]
DOEs approached for Validation bids	23rd August 2012	DOE Appointment Letter[16]

According to the Guidelines for the Demonstration of Additionality of Small Scale Project Activities (Version 9, EB68), at least one barrier listed shall be identified due to which the project would not have occurred any way.

The main barrier identified by the project owner at the date of decision making was the financial barrier and the project owner hence made the decision to implement the project as a CDM project activity. The existence of the barrier is demonstrated in the following by benchmark analysis.

As the project generates financial benefits other than CDM related income, investment comparison analysis or benchmark analysis needs to be used to demonstrate additionality. As there are no other credible and realistic baseline scenario alternatives other than electricity supply from the grid, benchmark analysis is chosen to prove additionality.

In the following, pre tax project IRR is used to demonstrate the Additionality of the project.

The purpose of investment analysis is to determine whether the proposed Project activity is not: the most economically or financially attractive; or economically or financially feasible, without the revenue from the sale of CERs. To conduct the investment analysis, the following sub-steps have been applied:

The "*Tool for the Demonstration and Assessment of Additionality" (Version 7.0)* 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 investent projects. The alternative baseline scenario of the proposed Project is the continuation of electricity supply from the Southern Lao PDR / EGAT Grid System (alternative (d)) which is not considered to be an investment. Therefore, as per the Additionality Tool (version 7.0) 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.

During the financial assessment of the Nam Sana Project activity in 2010 and the decision-making process in 2011, a discount rate of 10% was used to evaluate the Project. This is in line with the discount rate of 10% for government projects confirmed by the Government of Lao PDR and reflected in the Power System Development Plan (PSDP) 2004 for Lao PDR. Based on this, the pre-tax benchmark (FIRR) of 10% was selected by the Project proponent. A pre-tax Project Financial Internal Rate of Return (FIRR) was selected as the appropriate financial indicator for the Project.

The financial assumptions of the Project are outlined in the 2010 Feasibility Study (undertaken by Team Consultants). These are as follows in the table below.

[13] Copy Available

[14] Copy Available

[15] Copy Available

[16] Copy Available

Based on the Government of Lao investment benchmark, this resulted in the Project being not financially viable without the income from CERs (see Figure 8 and Figure 9 below).

It should be noted that the Feasibility Study assumes an extraordinarily long lifetime of 53 years (2.50 years for construction and 50.50 years of operation).

The benchmark analysis has been performed assuming a 25 year project lifetime. The alternative of 25 years has been selected because most projects in the private sector are Build Operate and Transfer (BOT) Projects which have a lifetime of 25 years. The typical IPP Concession Agreement is for 25 years, as is the Power Purchase Agreement. A project lifetime of 25 years is also more in line with the Guidelines on Investment Analysis which suggests a maximum period of 20 years[17]. However, 25 years is still a very conservative approach.

Parameter	Value	Reference
Installed Capacity	14MW	Feasibility Study[18]
Grid connected electricity output	49,550 MWh	Feasibility Study[19]
Construction Period	2.5 Years	Feasibility Study[20]
Operational Lifetime	25 years	Feasibility Study[21]
Depreciation Period	25 Years	Feasibility Study[22]
Expected Tariff	0.06 USD / kWh	Feasibility Study[23]
Project Cost	USD 26,840,000	Feasibility Study[24]
Tax	Zero	Feasibility Study[25]
Annual O&M Costs	USD 280,000	Feasibility Study[26]
Capital Replacement Cost	USD 4,800,000	Feasibility Study[27]
Crediting Period	3 x 7 Years	CDM Regulations

Table 2 Investment Assumptions

The table below shows the Project IRR for both a 25 year project.

Project Lifetime	Project IRR Without CDM Revenue	Project IRR With CDM Revenue
25 Years	8.35%	10.30%

Table 3 Project Internal Rate of Return

This table shows that the project IRR was lower than the benchmark of 10.00%.

[17] Guidelines on the Assessment of Investment Analysis (Version 5)

[18] Feasibility Study – Page 3

[19] Feasibility Study – page 11-3

[20] Ibid.

[21] Ibid.

[22] Ibid. Electro-mechanical equipment replaced in Year 25

[23] Ibid.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Ibid.

Sensitivity analysis

A sensitivity analysis of the project activity has been conducted to test the robustness of the above calculations. Although the O&M cost accounted less than 20% of total investment cost, it is still included in the project sensitivity analysis for more detail about the financial analysis. So the following parameters are used in the sensitivity analysis of the project activity:

- Annual Output exported to the national grid
- O&M costs
- Total Capital Costs
- Tariff

Table 7 shows the impact of variations in key factors on the project IRR considering a ±10% variation in the parameters.

	Increase / Decrease	
	5.00%	10.00%
Capacity Increase	8.963%	9.562%
Tariff Increase	8.963%	9.562%
Decrease in CAPEX	8.935%	9.553%
Reduction in O&M	8.408%	8.467%
Benchmark Return	10.000%	10.000%

This is shown graphically in the chart below.

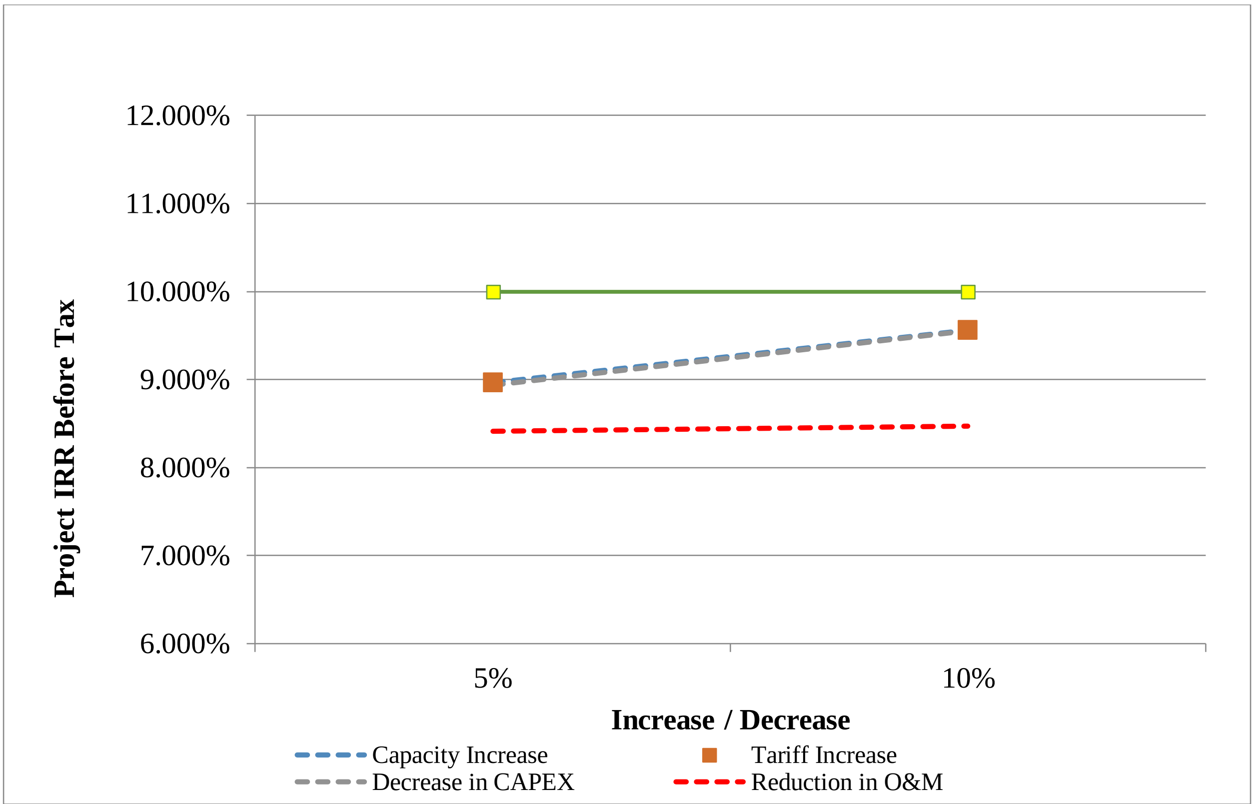

Figure 6 - Sensitivity Analysis

Further analysis below shows the levels of increase / reduction which are required to achieve the Benchmark Return of 10.00%.These paramters are summarized in the table below.

Capacity / Output Increase	
Output Required	66,500 GWh
IRR	10.00%
Increased Output	34.34%
Tariff Increase	
Current Levelized Tariff	$ 0.06000
Tariff Required	$ 0.08070
IRR	10.00%
Tariff Increase	34.50%
Reduction in CAPEX	
Current CAPEX	$ 26,840,000
CAPEX Required	$ 22,085,000
IRR	10.00%
CAPEX Reduction	17.72%
Reduction in O&M	
Current O&M	$ 280,000
O&M Required	$ (745,000)
IRR	10.00%
O&M Reduction	366.07%

Of the alternatives considered, the only way to achieve the benchmark would be a major increase in capacity (output), an increase in the tariff of a similar magnitude, or a reduction in the CAPEX.

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 34.34% to 66.50GWh 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.
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 34.50%, 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. However, currencies have not been stable and the most competitive bid for the civil works (a large proportion of the cost) was received from a Thai contractor. That contractor bid in USD and the value of the USD compared to the Thai Baht is much lower than it was at the time of bidding. The most competitive bidder is already earning less than expected because the contract is in USD and will not lower the price. There were numerous bidding round and any further reduction in CAPEX, which would be needed to exceed the benchmark, are not possible.
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.

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

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 *(PEy)*

According to the AMS.ID, 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:

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

$PE_{FF,y}$ backup power emissions

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

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

This is a Run of River project and there is no reservoir

II. Baseline emissions *(BEy)*

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:

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

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 02.2.1 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 (*EFgrid,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 (2008, 2009 and 2010) 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 (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 (LMCR) Power Generation are shown in the table below.

Year	Thailand		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
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
2010	160,191	7,587	Thailand Greenhouse Gas Office

Year	Lao PDR		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
2006	1,639	1,639	EdL Statistics Yearbook 2011
2007	1,398	1,398	EdL Statistics Yearbook 2011
2008	1,778	1,778	EdL Statistics Yearbook 2011
2009	1,656	1,656	EdL Statistics Yearbook 2011
2010	1,553	1,553	EdL Statistics Yearbook 2011

Year	Total low-cost / must run power generation in the grid	Total power generation in the grid	Percentage of low-cost/must run
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%
2010	9,140	161,744	5.65%

Table 4 - Details of LCMR Plants

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 CO_2 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 is used and then the simple OM emission factor is calculated as follows:

$$EF_{grid,OM,y} = \frac{\sum_{m} EF_{EL,m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

EFgrid,OM,y	the Simple operating margin CO2 emission factor in year *y* (tCO2/GWh)
EGm,y	the net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (GWh)
EFEL,m,y	the CO2 emission factor of power unit *m* in year *y* (tCO2/GWh)
m	All power plants/units serving the grid in year *y* except low-cost/must-run power plants/units
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 ante option)

Operating Margin emission factor of the most recent 3 years (2008, 2009 and 2010)

Year	2008	2009	2010	EFgrid,OM (tCO2 / MWh)
Total emissions of the Grid (tCO2e)	84,083,369	82,178,673	88,452,088	0.5994
Total electricity delivered to the grid by fossil power sources (MWh)	136,116,114	136,193,800	152,603,730	

So the *EFgrid,OM,y* is derived as follows:

$$EF_{grid,OM,y} = 0.5994 \text{ tCO2 / MWh}$$

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.

Option 1 (ex-ante), Condition (b) has been selected to calculate the Build Margin. All of the plants most recently commissioned are in the Thai part of the regional grid.

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 comprise larger than or equal to 20% of total annual electricity generation (in year 2010) are shown in Table 5. Fuel consumption of these power units are shown in Table 6.

Power Unit	Grid Generation (GWh)	COD
North Bangkok Power Plant (Unit 01)	1,584.22	19/11/2010
Bangpakong Power Plant (Unit 05)	4,643.22	16/9/2009
Phu Kieaw Bio Power Project 2	79.46	15/9/2009
Dan Chang Bio Power Project 2	76.75	15/9/2009
South Bangkok Power Plant (Unit 03)	4,431.92	1/3/2009
Chana Power Plant (Unit 01)	5,090.02	15/7/2008
Ratchaburi Power Company Limited (RPCL) (Unit 1 & 2)	7,124.72	1/7/2008
Gulf Power Generation Co., Ltd. (Unit 1 & 2)	9,903.93	1/3/2008
Summary	32,934.25	-
Percentage as of 2010 Grid Generation (160,190.96 GWh)	20.56	-

Table 5 - Most Recently Connected Power Plants which Represent 20% of Total Generation

Fuel Type	Fuel Consumption		CO^2 Emission ($kgCO^2$/Unit)	CO^2 Emission (tCO^2)
	Unit	Volume		
Total	-	-	-	-
Natural Gas	scf.	251,512,881,819	0.0554	13,930,292
Lignite	ton	-	951.7230	-
Bituminous	ton	-	2,360.1150	-
Bunler	litre	-	3.0026	-
Diesel	litre	1,179,772	2.6441	3,119

Table 6 - Fuel Consumption of Recently Built Plants

As can be seen from Table 5 above, details the five most recently constructed plants which generate power on the grid can be summarized as follows :

Power Unit	Grid Generation (GWh)	COD
North Bangkok Power Plant (Unit 01)	1,584.22	19/11/2010
Bangpakong Power Plant (Unit 05)	4,643.22	16/9/2009
Phu Kieaw Bio Power Project 2	79.46	15/9/2009
Dan Chang Bio Power Project 2	76.75	15/9/2009
South Bangkok Power Plant (Unit 03)	4,431.92	1/3/2009
Power Generated by 5 Most Recently Constructed Plants	10,815.57	-

Table 7 - Power Generation by 5 Most Recently Constructed Plants

Since the power generation from the units identified in Table 5 (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:

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

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:

$$\mathbf{EF_{grid,BM,y} = 0.4231\ tCO_2/MWh}$$

Step 7. Calculate the combined margin emissions factor

The weighted average CM method (Option a) is used. The CM emissions factor is calculated as follows:

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

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:

$$EF_{grid,CM,y} = 0.5994 * 0.50 + 0.4231 * 0.50 = 0.5113$$

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

Project Emissions

According to AMS-I.D. (Version 17.0), as run-of-river hydropower project with no reservoir, the project emission PE_y **=** 0.

However, the project will use a diesel generator for start-up procedures and the CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuels combusted and the CO_2 emission coefficient of those fuels, as follows:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y} \quad (1)$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year *y* (tCO_2/yr)
$PE_{GP,y}$	=	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y* (tCO_2e/yr)
$PE_{HP,y}$	=	Project emissions from water reservoirs of hydro power plants in year *y* (tCO_2e/yr)

In this case, the project is a hydro power project and hence the provisions regarding a geothermal plant do not apply, and the reservoir emissions can be disregarded because of the power density.

According to the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02), project emissions from the combustion of fossil fuels are calculated as follows :

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where :

PE FC,j,y	=	The CO2 emissions from fossil fuel combustion in process j during the year y (tCO2/yr)
FC i,j,y	=	The quantity of fuel type i combusted in process j during the year y (mass or volume unit / yr)
COEF i, y	=	The CO2 emission coefficient of fuel type i in year y (tCO2 / mass or volume unit)
i	=	The fuel types combusted in process j during the year y

III. Leakage *(LEy)*

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

IV. Reduction emissions *(ERy)*

Emission reductions are calculated as follows:

ERy= BEy- PEy- LEy

Where:

ERy Emission reductions in year *y* (tCO2e/y).
BEy Baseline emissions in year *y* (tCO2e/y)
PEy Project emissions in year *y* (tCO2/y).
LEy Leakage emissions in year *y* (tCO2/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 2010, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2008,2009 and 2010
Value(s) applied:	0.5994
Choice of data or Measurement methods and procedures	Calculated as per “Tool to calculate the emission factor an electricity system” version 04 with 3-year vintage data and option of *ex-ante* calculation based on Simple Operating Margin Method
Purpose of data	To calculate emission reductions
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 2010, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2008,2009 and 2010
Value(s) applied:	0.4231
Choice of data or Measurement methods and procedures	Calculated as per “Tool to calculate the emission factor an electricity system” version 04 with *ex-ante* calculation based on sample group m comprising of 20% of the system generation (in MWh)
Purpose of data	To calculate emission reductions
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 2010, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2008, 2009 and 2010
Value(s) applied:	See table 3 in Annex 3
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	To calculate emission reductions
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 2010, published by the Thailand Greenhouse Gas Office (TGO) and the EdL Annual reports 2008, 2009 and 2010)
Value(s) applied:	Varies for each fuel types. These are : Fuel / Unit / NCV Natural Gas / scf. / 1.02 Lignite / ton / 10,470.77 Bituminous / ton / 26,370.00 Bunker / litre / 39.77 Diesel / litre / 36.42
Choice of data or Measurement methods and procedures	Use for unit conversion.
Purpose of data	To calculate emission reductions
Additional comment:	Study of Emissions Factor for an Electricity System in Thailand 2010, published by the Thailand Greenhouse Gas Office (TGO)

Fuel	Unit	NCV
Natural Gas	scf.	1.02
Lignite	ton	10,470.77
Bituminous	ton	26,370.00
Bunker	litre	39.77
Diesel	litre	36.42

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. These are :
Choice of data or Measurement methods and procedures	NA
Purpose of data	To calculate emission reductions
Additional comment:	NA

Fuel	tCO2 / TJ
Natural Gas	54.30
Lignite	90.90
Bituminous	89.50
Bunker	75.50
Diesel	72.60

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:	0.5113

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	To calculate emission reductions
Additional comment:	NA

B.6.3. Ex ante calculation of emission reductions

Baseline emissions

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:

$$EG_y = EG_{BL,y} * EF_{grid,CM,y}$$

Where:

EGy= Electricity supplied by the Nam Sana Hydropower Plant to the grid

$EG_{BL,y}$ = 49,550,000 KWh = 49,550 MWh

$EF_{grid,CM,y}$ = 0.5113 tCO2/MWh

Therefore,

therefore:

BE_y = 49,550 x 0.5113 = 25,335 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:

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

$PE_{FF,y}$ is backup power emissions

$PE_{HP,y}$ 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 14.00 MW which is a Run of River design and does not require a reservoir.

Therefore Project Emissions from the Reservoir can be disregarded from the Emissions Reductions Calculations as the power density is above 10W/M².

Emission from diesel backup generators (PEFF,y)

In ex ante emission calculation, the diesel consumption is assumed as zero. Because in a very special case when the generation from the plant is temporarily terminated, diesel back-up generators with installed capacity of 250KVA will be used to generate electricity for internal use in the plant. However, this case rarely happens and is not at any frequency. Even in case it happens, it's expected that it will last during a couple of days only. Furthermore, fuel consumed for the power backup is expected very small. It is not possible to estimate this emission *ex ante*. Therefore, the emission from this source is considered very negligible or $PE_{FF,y} = 0$ *ex ante*. The accurate emission is monitored and calculated PEFF in year *y.*

Therefore the GHG emission from the project activity is considered as zero.

$$PE_y = PE_{FF,y} + PE_{HP,y} = 0$$

The accurate emission is monitored and calculated PEFF in year *y.*

CO2 emissions from fossil fuel combustion in process j are calculated based on the quantity of fuels combusted and the CO2 emission coefficient of those fuels, as follows:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,j}$$

Where:

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

The CO2 emission coefficient $COEF_{i,y}$ can be calculated using one of two Options, depending on the availability of data on the fossil fuel type i, and in this case Option A will be used to calculate the ex-post project emissions.

Option A

TheCO2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i, using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit : $COEF_{i,y} = w_{c,i,y} \times 44/12$
If $FC_{i,j,y}$ is measured in a volume unit : $COEF_{i,y} = w_{c,i,y} \times \rho_{i,y} \times 44/12$

Where:

$COEF_{i,y}$ = Is the CO_2 emission coefficient of fuel type i (tCO_2/mass or volume unit);
$w_{C,i,y}$ = Is the weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of the fuel);
$\rho_{i,y}$ = Is the weighted average density of fuel type i in year y (mass unit/volume unit of the fuel)
i = Are the fuel types combusted in process j during the year y

Leakage

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

Reduction emissions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - L_y = 25{,}335\ tCO2/y$$

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

Year	Baseline emissions (tCO_2 e)	Project emissions (tCO_2 e)	Leakage (tCO_2 e)	Emission reductions (tCO_2 e)
2015	25,335	0	0	25,335
2016	25,335	0	0	25,335
2017	25,335	0	0	25,335
2018	25,335	0	0	25,335
2019	25,335	0	0	25,335
2020	25,335	0	0	25,335
2021	25,335	0	0	25,335
Total	177,345	0	0	177,345
Total number of crediting years	7			
Annual average over the crediting period	25,335			

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	EGy, export
Unit	MWh
Description	Electricity supplied by the proposed hydropower plant to the grid
Source of data	Direct measurement at the connection point
Value(s) applied	49,550
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.
Purpose of data	To calculate Emissions Reductions
Additional comment	No Comment

Data / Parameter	**EGy, import**
Unit	MWh
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	To calculate Emissions Reductions
Additional comment	No Comment

Data / Parameter	$EG_{BL,y}$
Unit	MWh
Description	Net electricity supplied to the grid by the proposed hydropower plant
Source of data	Monitored by the Measured Values as the difference between **EGy, export** and **EGy, import**
Value(s) applied	49,550
Measurement methods and procedures	Calculating by subtracting EGy, import from EGy, export. Double checking by the joint balance sheet issued by EVN and project owner to ensure the consistency. 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
Purpose of data	To calculate Emissions Reductions
Additional comment	No 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	14,000,000
Measurement methods and procedures	Manufacturer’s Nameplate
Monitoring frequency	Yearly
QA/QC procedures	No National Standard
Purpose of data	To calculate Emissions Reductions
Additional comment	No Comment

Data / Parameter	$FC_{i,j,y}$
Unit	Mass or volume per unit per year
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Project Site
Measurement methods and procedures	Volume meters or, if small daily tanks are used, by using a ruler whereby the gauge is part of the daily tank and calibrated at least one per year.
Monitoring frequency	Continuous
QA/QC procedures	The consistency of metered fuel consumption quantities will be cross-checked by an annual energy balance that is based on amounts purchased and stock changes.
Purpose of data	To calculate Emissions Reductions
Additional comment	No Comment

Data / Parameter	$NCV_{i,j,}$
Unit	GJ per mass or volume unit
Description	Weighted average net calorific value of fuel type i in year *y*
Source of data	IPCC Default Standards at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement methods and procedures	Calculated
Monitoring frequency	Annually and any future revisions of the IPCC guidelines will be taken into account
QA/QC procedures	NA
Purpose of data	To calculate Emissions Reductions
Additional comment	No Comment

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	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.
Source of data	As per the Tool to calculate the emission factor for an electricity system.
Measurement methods and procedures	As per the Tool to calculate the emission factor for an electricity system.
Monitoring frequency	As per the Tool to calculate the emission factor for an electricity system.
QA/QC procedures	As per the Tool to calculate the emission factor for an electricity system.
Purpose of data	To calculate Emissions Reductions
Additional comment	The BM shall be calculated annually and the OM remains an ex-ante calculation

Data / Parameter	$EF_{CO2,j,y}$
Unit	tCO_2 / GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y

Source of data	IPCC Default Standards at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Volume 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement methods and procedures	Calculated
Monitoring frequency	Annually and any future revisions of the IPCC guidelines will be taken into account
QA/QC procedures	NA.
Purpose of data	To calculate Emissions Reductions
Additional comment	No Comment

B.7.2. Sampling plan

There will be no sampling plan as the actual amounts of electricity generated and delivered to the grid will be monitored by meters.

B.7.3. Other elements of monitoring plan

Because the baseline emission factor of Grid (*EFgrid,CM,y*) is fixed ex-ante (detail in Section B.6), the main data to be monitored is *EGBL,y.* EGBL,ywill be calculated according to the formula below*:*

EGBL,y, = EGy, export - EGy, 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. The calibration of the meters, and dispute procedures, is established in power purchase agreements.[28]

The technical characteristics, description, accuracy and calibration of the Meters shall comply fully with the requirements of IEC 60687.

The Meters shall be of an accuracy class 0.2S and shall measure the Net Electrical Output and Imported Energy to within ±0.2% of the correct value. The Meters shall be tested in an independent and suitably qualified laboratory reasonably acceptable to the both Parties or controlled by the third party.

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.

[28] The calibration and checking procedures are detailed in the standard PPA.

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 Sana Project and will follow on from the Workshop held at EdL in Vientiane in November 2011.[29] This will take place initially during the construction period, and then as soon as practicable following Commissing.

For further details see Annex 4.

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. 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

[29] 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

The CDM Glossary of Terms (Version 5) defines the Starting Date of the Project Activity as follows:

In light of the above definition, the start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity. This, for example, can be the date on which contracts have been signed for equipment or construction/operation services required for the project activity. Minor pre-project expenses, e.g. the contracting of services /payment of fees for feasibility studies or preliminary surveys, should not be considered in the determination of the start date as they do not necessarily indicate the commencement of implementation of the project. For those project activities which do not require construction or significant pre-project implementation (e.g. light bulb replacement) the start date is to be considered the date when real action occurs. In the context of the above definition, pre-project planning is not considered "real action".

Based on this definition, the Starting Date of the Project is **19th September 2011** which is the date that the Project Participant and the EPC Contractor committed to the obligations in the EPC Contract.

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

Renewable

C.2.2. Start date of crediting period

1st January 2015

C.2.3. Length of crediting period

7 Years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The Initial Environmental Examination (IEE) was prepared in accordance with the numerous laws and decrees issued by the Government of Lao PDR and also in accordance with International Standards.

A detailed topographic survey scale 1:1,000 for 1 m contour interval was conducted to get a data for feasibility level designed drawings. The task was carried out by the National Geographic Department (NGD) of Lao. The scope of work for this task included:

Permanent Benchmark Establishment

A pair of permanent benchmarks was established close to each main project structure including weir, surge tank and powerhouse. The coordinate and datum is referred to the standard benchmark of NGD at Kasi district. Its descriptions are coordinate in Lao 97 system.

The established benchmark was sed as the control point for the detailed survey of the specified area.

Detailed Topographic Survey

The detailed topographic survey covering the weir site, power waterway and powerhouse at 1:1,000 scale with 1 m contour interval occupies total area of about 190 ha.

D.2. Environmental impact assessment

Meteorology and Hydrology

Nam Sana River Basin is in the Central of Lao PDR and in a sub-equatorial monsoon climate with three distinct seasons: (i) wet hot season from May to October; (ii) dry cool season from November to February; and (iii) dry hot season from March to April. In September and June, it is covered by Intertropical Convergence Zone where the Northeast and Southeast Trades Wind meet and generate tropical depression

Noise

Nam Sana Hydropower Project activities will emit operational noise which can effect nearby sensitive receptors. Therefore, the study of existing of noise level in the project area was necessary in order to establish baseline data for assess the potential impact due to project implementation and prepare mitigation measures and monitoring program.

Based on the field surveys during 25-31 August 2010 there are no sensitive receptors around weir site, powerhouse, and power waterway area because these areas are situated in remote forest and mountain ranges. Most of surrounding is forest area. The nearest community of the project is Ban Namphot. It is approximately 5.8, 3.5 and 3.2 km from weir site, powerhouse and power waterway, respectively.[30]

Vibration

The construction of Nam Sana Hydropower Project could generate vibration impact to nearby sensitive receptors due to activity of drilling, excavating and vibrating machinery. Therefore, the

[30] IEE Report Page 4-2

study of existing vibration level of project area is necessary in order to establish baseline data for assessment on vibration impact due to the project implementation.[31]

Hydrology

The hydrology study aims i) to examine hydrology within the project site and ii) to assess an expected impact on hydrology and propose mitigation measures and monitoring program.

A detailed hydrological study was undertaken which covered water quality, sedimentation,

The IEE Report further covered the following topics in accordance with the regulations of the Lao PDR

- SurfaceWater Quality
- Soil and Erosion
- Topography / Geology / Seismology
- Aquatic Ecology/Fishery
- Forest Resources
- SurfaceWater Quality
- Soil and Erosion
- Topography / Geology / Seismology
- Aquatic Ecology/Fishery
- Forest Resources

It was found that the Project Impacts in all of these areas will be minimal[32] and that where appropriate the Project Owner would carry out the necessary mitigation measures.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

Public Consultation for IEE of Nam Sana Hydropower Project was conducted in accordance with relevant policy, regulations and guidelines of Lao PDR. The emphasis was made on the project information dissemination, and public participation for obtaining comments and suggestion from the relevant stakeholders. Public Consultation for IEE of Nam Sana Hydropower Project was conducted in accordance with relevant policy, regulations and guidelines of Lao PDR.[33] The emphasis was made on the project information dissemination, and public participation for obtaining comments and suggestion from the relevant stakeholders.

There were 4 main activities undertaken conducting of IEE for Nam Sana Hydropower Project, which were as follows:

- To inform and Consult with relevant government offices and head of the villages in areas are expected to be affected from weir construction and operation as Ban Phonngam, Ban Naxou, Ban Namphot and Ban Nasangthong.
- To inform and Consult with relevant government offices and head of the villages in areas are expected to be affected from transmission line as Ban Phonngam, Ban Naxou
- To organize public consultation meetings.
- Attitude survey by questionnaire for government's officers in public consultation meeting.

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[31] IEE Report Page 4-4

[32] IEE Report Chapter 4

[33] The relevant statutes and decrees are listed in Chapter 2 of the IEE

The First Public Consultation

The first public consultations were targeted on relevant government offices and primary stakeholders to be directly affected. The first public consultation meeting was conducted during on 25-31August 2010.

(1) Objectives

- To inform the preliminary project information to relevant government officials' representatives of Vientiane province, representative of Kasi district administration organization, chief of villages and local people to be affected for understanding, and cooperation with the project.
- To perceive the suggestion and opinion of relevant government officials' representatives of Vientiane province, representative of Kasi district administration organization, chief of villages and local people to be included in the IEE study report.

(2) Materials

- Leaflet of Project description
- Power Point Presentation
- Questionnaire for Public Consultation I

The Second Public Consultation

The second public consultations were targeted on relevant government offices and villagers to be directly affected. The second public consultation meeting was conducted during on 25-28 December 2010.

(1) Objectives

- To inform the results of IEE for Nam Sana Hydropower project such as impacts, mitigation measures, monitoring program and compensation to relevant government officials as representatives of Vientiane province, representative of Kasi district administration organization, chief of villages and local people to be affected for understanding, and cooperation with the project.
- To perceive the suggestion and opinion of relevant government officials' representatives of Vientiane province, representative of Kasi district administration organization, chief of villages and local people to be included in the IEE study report.

(2) Materials

- Handout of Project description
- Power Point Presentation and Flip Chart (for villages no electricity)
- Questionnaire for Public Consultation II (for government officials)

E.2. Summary of comments received

The First Public Consultation Activities[34]

The following is a summary of public consultation meetings on provincial agencies, district agencies and community leaders. The participants made suggestions on the scoping of IEE study, with the following points raised

(1) Question Issues

[34] IEE Chapter 5 and Chapter 8

Public Participation and public relation to who live or cultivate in and/or nearby project area.
Project affected area during construction and operation phases i.e. flooding area, usage water shortages, loss of agricultural area and etc.
Amend, compensation and rehabilitation plan for directly project affected persons (PAPs).
The overlap between boundary of Sky Mining's concession area with project area.

(2) Opinions and Suggestions

- To contact and coordinate with relevant officials for notify any actions.
- To allocate lands or pay compensations for project affected persons.
- To develop electricity for households in every villages nearby project area.
- Furthermore, improvement incomplete primary school and local road in the village, building wooden bridge across Nam Sana River for Ban Namphot and Ban Nasangthong.
- Head of villages live along transmission line, they agreed with the project because it is no impact.
- Most of participants agree with the Nam Sana hydropower project development.

The Second Public Consultation Activities

The following is a summary of public consultation meetings on provincial, district and community levels. The participants suggested on the results of IEE study, mitigation measure, monitoring program and compensation. The recommendations are as follow,

- To improve mitigation measure cover all environmental (such as water resource, forestry, ecology, and etc.) and social impact by describe in more detail both construction and operation period.
- To emphasize prevention to chemical contaminated in Nam Sana River and other water resource, such as oil, lubricant, cement in liquid form and etc.
- Forest rehabilitation within project area.
- To consider compensation in affected area to be fair.
- To set committee including relevant officials from Vientiane province, Kasi district, chief of villages for monitoring the construction and operation activities of the project to follow the mitigation measure.
- To coordinated with Vientiane province, Kasi district and concerned villages throughout construction and operation periods.
- To develop road and bridge cross Nam Sana River between Ban Nasangthong and Ban Namphot, in order to access all year round. Because in rainy season, the villagers can't take vehicles cross the rivers. Therefore, unable to the transport agricultural products to sell.
- To develop primary school in Ban Nasangthong , Ban Namphot and Ban Namphueng (village next to the Ban Nasangthong) for children both 3 villages go to study together.
- Employment the villagers of Ban Namphot and Ban Nasangthong to work as laborers in the project construction.
- To develop irrigation to the farmland of Ban Namphot and Ban Nasangthong, so they can plants throughout the year.
- To support access road from Zinc Mining to the project area due to existing road condition is very steep.
- To provide husbandry animals for donating to poverty households.

The summary of the public consultation meeting found that they agreed with IEE of Nam Sana Hydropower project.

E.3. Report on consideration of comments received

It was agreed that local stakeholders would participate in the Implementation and Monitoring of the Environmental and Social Management Plan.[35]

In order to effectively and closely supervise and follow up the implementation of mitigation measures of Nam Sana Hydroelectric Power Project, it is proposed that the organization arrangement be unified and shall cover all aspects of Environmental Management Plan (EMP). The organization is thus proposed to be set up comprising:-

- Provincial Environmental Committee (PEC)
- District Environmental and Social Committee (DESC)
- Village Environmental and Social Committees (VESC)
- Grievance Redress Committee (GRC)
- Environmental Monitoring Unit (EMU)
- Social Monitoring Unit (SMU)
- Environmental Management Office (EMO)

To support and facilitate the committee, it is proposed that the management unit called Environmental Monitoring Unit (EMU) and Social Monitoring Unit (SMU) to be set up. This unit will comprise scientists seconded from WREA and group of experts/specialists engaged by the developer. This unit will assist and facilitate the committee on monitoring the implementation of EMP.

SECTION F. Approval and authorization

The Report was approved and authorized by the Ministry of Natural Resources and Environment on 21st May 2012.[36]

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[35] IEE Chapter 9

[36] Certificate and Translation

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	Electricité du Laos, Lao PDR
Street/P.O. Box	PO Box 309, Mittaphab Lao-Thai Road
Building	
City	Vientiane
State/Region	-
Postcode	-
Country	Lao PDR
Telephone	+856 (21) 451519
Fax	+856 (21) 453408
E-mail	vilaphorn05@gmail.com
Website	http://www.edl-laos.com
Contact person	Managing Director
Title	Mr.
Salutation	Thiravong
Last name	-
Middle name	Sisavath
First name	-
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	Eneco Energy Trade, B.V., Netherlands
Street/P.O. Box	Marten Meesweg 5
Building	-
City	Rotterdam
State/Region	-
Postcode	3068AV
Country	Netherlands
Telephone	+31 888954806
Fax	-
E-mail	H.Jiang@eneco.nl
Website	www.eneco2.com
Contact person	-

Title	Carbon Trading Manager
Salutation	Mr.
Last name	Jiang
Middle name	-
First name	-
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 from Annex 1 countries is involved in the project.

Appendix 3. Applicability of methodology and standardized baseline

Not Applicable

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 2008, 2009 and 2010.

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 (2008, 2009 and 2010) 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 B) 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.

The combined margin emission factor ($EF_{grid,CM,y}$) is calculated as per methodological tool "Tool to calculate the emission factor an electricity system" version 04.0, 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 B), not including low-operating cost and must-run power plants as follows:

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

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		CO2 emission coefficient		
	MJ/Unit	Unit	tCO2/TJ	kgCO2/Unit	Unit
Natural gas	1.02	scf.	54.3	0.055	scf
Lignite	10,470.00	ton	90.9	951.723	ton
Bituminous	26,370.00	ton	89.5	2360.115	ton
Bunker	39.77	litre	75.5	3.002	litre
Diesel	36.42	litre	72.6	2.644	litre

Table 8 - Fuel Emission Coeffecients

Fuel Type	Fuel Consumption		CO² Emissions	
	Unit	Volume	(kgCO²/Unit)	CO² Emission (kgCO²)
2010				
Total				88,452,088
Natural Gas	scf.	1,073,084,673,019	0.0554	59,433,868
Lignite	ton	16,043,174	951.7230	15,268,658
Bituminous	ton	5,502,160	2,360.1150	12,985,730
Bunker	litre	233,229,746	3.0026	700,304
Diesel	litre	24,026,558	2.6441	63,528
2009				
Total				82,178,673
Natural Gas	scf.	968,924,717,809	0.0554	53,664,864
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	474,469
Diesel	litre	13,825,937	2.6441	36,557
2008				
Total				84,083,369
Natural Gas	scf.	977,016,893,281	0.0554	54,113,058
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	1,051,551
Diesel	litre	51,941,958	2.6441	137,339

Table 8 shows the CO_2 emission from each fuel type generated from the national grid system during 2008-2010. According to the methodological tool, imported electricity should be included in the

Table 9 - CO2 Emission Factors

calculation with zero tCO_2/MWh. The results in Table 11 show that the 3-year average OM emission factor is 0.5994 tCO_2/MWh

Details of the Low Cost / Must Run (LMCR) Power Generation are shown in the table below.

Year	Thailand		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
2006	139,422	9,961	Thailand
2007	144,364	10,383	Thailand
2008	145,232	9,116	Thailand
2009	145,300	9,106	Thailand
2010	160,191	7,587	Thailand

Year	Lao PDR		
	Total Power Generation (GWh)	LCMR Power Generation (GWh)	Data source
2006	1,639	1,639	EdL Statistics
2007	1,398	1,398	EdL Statistics
2008	1,778	1,778	EdL Statistics
2009	1,656	1,656	EdL Statistics
2010	1,553	1,553	EdL Statistics

Year	Total low-cost / must run power generation in the grid	Total power generation in the grid	Percentage of low-cost/must run
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%
2010	9,140	161,744	5.65%

Table 10 - Details of LCMR Plants

Year	CO² Emissions (tCO²)	Grid Consumption (GWh)	OM Factor (tCO² / MWh)
2010	88,452,088	152,603.73	0.5796
2009	82,178,673	136,193.80	0.6034
2008	84,083,369	136,116.14	0.6177
Summary	254,714,130	424,913.67	0.5994

Table 11 - OM Emissions Factor 2010

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:

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

Where:

$EF_{grid,BM,y}$ = Buid margin CO_2 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

List of five IPPs, comprise 20.56% of the total electricity generation, is used in the BM emission factor calculation shown in the table 12. The BM emission factor of the national grid system equals to 0.4231 tCO_2/MWh as shown in the table below.

Power Unit	Grid Generation (GWh)	COD
North Bangkok Power Plant (Unit 01)	1,584.22	19/11/2010
Bangpakong Power Plant (Unit 05)	4,643.22	16/9/2009
Phu Kieaw Bio Power Project 2	79.46	15/9/2009
Dan Chang Bio Power Project 2	76.75	15/9/2009
South Bangkok Power Plant (Unit 03)	4,431.92	1/3/2009
Chana Power Plant (Unit 01)	5,090.02	15/7/2008
Ratchaburi Power Company Limited (RPCL) (Unit 1 & 2)	7,124.72	1/7/2008
Gulf Power Generation Co., Ltd. (Unit 1 & 2)	9,903.93	1/3/2008
Summary	32,934.25	
Percentage as of 2010 Grid Generation (160,190.96 GWh)	20.56	

Table 12 - Most Recent Grid Connected Power Plants which Represent 20% of Total Generation

Fuel Type	Fuel Consumption		CO^2 Emission (kgCO²/Unit)	CO^2 Emission (tCO²)
	Unit	Volume		
Total	-	-	-	-
Natural Gas	scf.	251,512,881,819	0.0554	13,930,292
Lignite	ton	-	951.7230	-
Bituminous	ton	-	2,360.1150	-
Bunler	litre	-	3.0026	-
Diesel	litre	1,179,772	2.6441	3,119

As can be seen from Table 13 below, details the five most recently constructed plants which generate power on the grid can be summarized as follows :

Power Unit	Grid Generation (GWh)	COD
North Bangkok Power Plant (Unit 01)	1,584.22	19/11/2010
Bangpakong Power Plant (Unit 05)	4,643.22	16/9/2009
Phu Kieaw Bio Power Project 2	79.46	15/9/2009
Dan Chang Bio Power Project 2	76.75	15/9/2009
South Bangkok Power Plant (Unit 03)	4,431.92	1/3/2009
Power Generated by 5 Most Recently Construted Plants	10,815.57	-

Table 13 - Power Generation by the 5 Most Recently Constructed Plants

Since the power generation from the units identified in Table 12 (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 (Table 13) those plants shown in Table 12 have been selected to calculate the Build Margin.

Build Margin 0.4231 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:

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

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 a power generation project are 50% and 50% respectively as stated in the tool. The CM emission factor is calculated as shown in the equation above:

The Table below demonstrates that the baseline emission factor of the regional electricity system in 2010 is 0.5113 tCO_2/MWh.

	Weight	Emission Factor
Operating margin	0.50	0.5994
Build margin	0.50	0.4231
Baseline (Combined margin)		**0.5113**

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)	0.5113
Electricity generation (MWh)	49,550
Baseline emission (tCO_2/ year)	25,335
Total baseline emission (tCO_2/ year)	**25,335**

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
PE_y = Project emissions in year y, tCO_2e yr

Table 14 illustrates ex ante emission reduction and annual average of the estimated reductions over the crediting period.

Year	Baseline emissions (tCO_2 e)	Project emissions (tCO_2 e)	Leakage (tCO_2 e)	Emission reductions (tCO_2 e)
2015	25,335	0	0	25,335
2016	25,335	0	0	25,335
2017	25,335	0	0	25,335
2018	25,335	0	0	25,335
2019	25,335	0	0	25,335
2020	25,335	0	0	25,335
2021	25,335	0	0	25,335
Total	177,345	0	0	177,345
Total number of crediting years	7			
Annual average over the crediting period	25,335			

Table 14 - Ex-Ante Emission Reductions

Appendix 5. Further background information on monitoring plan

Not Applicable

Appendix 6. Summary of post registration changes

The Project is under the process of submitting the PDD to the 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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