Project design document form

(Version 10.1)

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

BASIC INFORMATION	
Title of the proposed CDM project activity	Nam Kap Hydropower Project
Scale of the proposed CDM project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	03.1
Completion date of the PDD	26/07/2019
Project participants	PHONGSUBTHAVY Group Swiss Carbon Assets Ltd.
Host Party	Lao PDR
Applied methodologies and standardized baselines	Methodology: AMS-I.D. (Version 18.0) Grid connected renewable electricity generation.
Sectoral scopes linked to the applied methodologies	Sectoral Scope 1: Energy Industries
Estimated amount of annual average GHG emission reductions	30,252 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Nam Kap Hydropower Project (hereafter referred to as the "the project") is located in the Longsan district of the Xaysomboun province of Lao PDR, 30km east of Vangvieng town centre, in the border line between Longsan district and Vangvieng. district, and developed by PHONGSUBTHAVY Group. The geographical coordinates of dam and penstock are 102°43′48″E, 19°1′8″N and 102°44′19″E, 19°1′9″N respectively.

The project is a run-of-the-river hydropower station. The installed capacity is 12MW(2*6MW), with annually 54.07 GWh power supplied to the power grid, which is small-scale(Type I- maximum output capacity equivalent of up to 15 megawatts). The technological details have been provided in setion A.3.

The project is expected to constantly contribute clean energy to the Lao Power Grid. For the Lao Power Grid is connected with the power grid in Thailand, the power supplied by the project will not only meet domestic electricity demand, but also increase the net power export to Thailand and decrease the net power import from Thailand, where the power grid is dominated by thermal power plants. The baseline scenario of the project is continuation of the present situation, i.e. electricity supplied from the power grid. By displacing part of the power generated by thermal power plants, the project is therefore expected to reduction of CO_2 emissions by an estimated 30,252 t CO_2e per year and total 211,764 t CO_2e during the first crediting period of 7 years.

The regional grid consisting of Thailand Power Grid and the Lao Power Grid is adopted as the proposed CDM project boundary. According to AMS-I.D., 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.

As a renewable energy project, the proposed CDM project will produce positive environmental and economic benefits and contribute to the local sustainable development in following aspects:

- During the construction period, plenty of job opportunities were provided to local residents, and the newcomers surged in the area will bring local people lots of employment opportunities thus bring more revenue for the local residents;
- The infrastructures were greatly improved. The implementation of water supply program, transportation and electricity system enhancement will bring substantial benefits to local villagers;
- Reduce the local use of firewood displacing by electricity, reduce the damage to the local vegetation;
- Power supplied to the regional grid consisting of Thailand Power Grid and the Lao Power Grid, will provide clean & cheap electricity power in this region, promotes the sustainable development in this region and slowing down the increasing trend of GHG emissions.

A.2. Location of project activity

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The proposed CDM project is located in Longsan district of the Xaysomboun province of Lao PDR., 30km east of Vangvieng town centre, in the border line between Longsan district, Xaysomboun Province and Vangvieng District Vientiane Province. The geographical coordinates of dam and penstock are 102°43′48″E, 19°1′8″N and 102°44′19″E, 19°1′9″N respectively.

More details about the hydropower station from geological point of view can be seen in the following map:

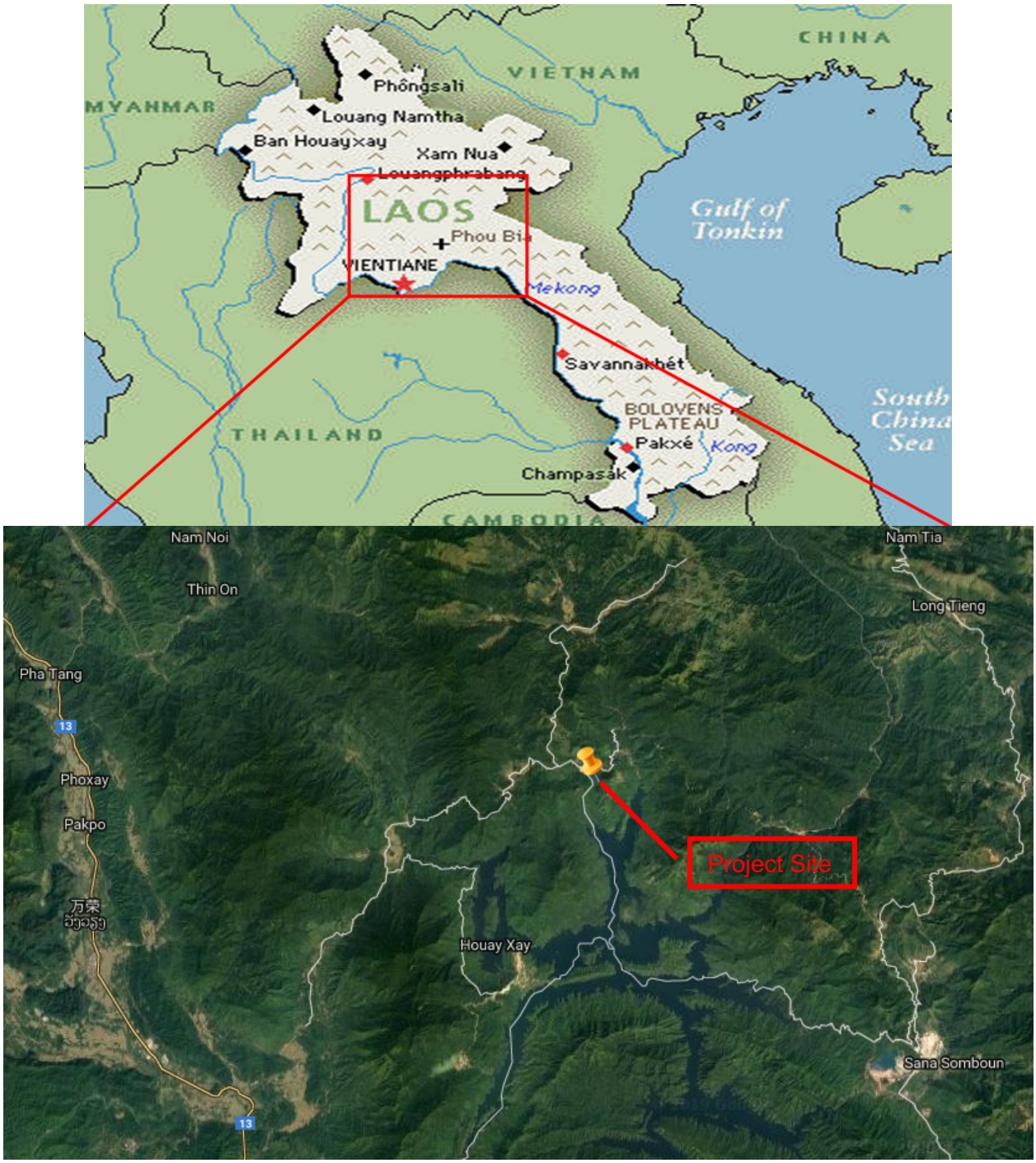

Figure A.1. Location of the proposed CDM project

A.3. Technologies/measures

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After completion of the proposed CDM project, the newly built plant will provide clean electric power to the regional grid consisting of Thailand Power Grid and the Lao Power Grid. The scenario prior to the start of implementation of the proposed CDM project activity is provision of the equivalent amount of electricity generated by the power plants connected with the regional grid, which is dominated by thermal power plants, thus leads to mass of GHG emissions. The baseline scenario is the same as the scenario prior to the start of implementation of the proposed CDM project activity.

The Project is a run-of-river hydropower project. The total install capacity of the project is 12MW(2*6MW). The construction of the project includes fixed weir, a sand trap, intake, headrace

canal, headrace tunnel, forebay, penstock, powerhouse and a tailrace. The power generated will be delivered to Electricite Du Laos(EDL).

The source of Main parameters of the project is equipment contract. The table below summarizes the main technical features of the project.

Table A.1 Main parameters of the proposed CDM project

Parameter		Unit	Value
Turbine	Type	Pelton	
	Number	Set	2
	Nominal Discharge per Unit	m^3/s	2.62
	Normal Gross head	m	287
	Maximum Net Head	m	284.86
	Minimum Net Head	m	270.79
	Nominal speed	rpm	750
	Turbine Centre Line Elevation	masl	385
	Lifetime[1]	hours	150000
Generator	Manufacturer	PARTZSCH	
	Type	SGH-089/08S3-110-SW	
	Nominal Speed	rpm	750
	Rated Capacity per generator	KW	6000
	Number	Set	2
	Rated voltage	v	11000
	Frequency	Hz	50
	Nominal Power Factor	-	0.85
	Lifetime	years	30

The power generated by the two 6MW generators will be supplied to transformer substation through a 115 kV single-circuit transmission line to Lao Power Grid.

The annual net electricity supply for the project will be 54.07GWh, two meters will be installed to monitor the input/output power. The meters M will be the main meter, installed at the grid access points, to monitoring the input/output electricity at the grid side. The meters M' will be the backup meter for M, respectively, parallel combined with M. When there is anything wrong with the main meter, the backup meter will be adopted. The accuracy of all meters will be not less than 0.5S. (Refer to Figure B.1 for details)

There is no technology/measure transferred to the host party.

A.4. Parties and project participants

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Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)

[1] According to Tool to determine the remaining lifetime of equipment(EB 50 annex 15, version 01), the lifetime of Hydor turbines is 150000 hours and Electric generators water cooled is 30 years.

Lao PDR (host)	PHONGSUBTHAVY Group	No
Switzerland	Swiss Carbon Assets Limited	No

A.5. Public funding of project activity

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The proposed CDM project does not receive any public funding from Parties included in Annex I of the UNFCCC. The proposed CDM project does not use ODA directly or indirectly.

A.6. History of project activity

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1. PP hereby confirms that:
   The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities.
   The proposed CDM project activity is not a project activity that has been deregistered.
2. PP further declares that:
   The proposed CDM project activity was not a CPA that has been excluded from a registered CDM PoA;
   No registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

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The project activity is not a de-bundled component of a larger project activity as explained below.

As per “Methodological tool: Assessment of debundling for SSC project activities”, Version 04, Para 9 “A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:
(a) With the same project participants;
(b) In the same project category and technology/measure; and
(c) Registered within the previous 2 years; and
(d) Whose project boundary is within 1 km of the project boundary of the proposed small- scale activity at the closest point.

The project owner indicates that there is not a registered small-scale CDM project activity or an application to register another small-scale CDM project activity in accordance with any condition mentioned above, therefore the project is not a de-bundled component of a large project activity.

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

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Baseline methodology:
Title：Type-I, Renewable Energy Project
AMS-I.D. Grid connected renewable electricity generation (Version 18, EB 81).

This methodology draws upon the following tools:
Tool for the demonstration and assessment of additionality (Version 7.0.0, EB 70),Tool to calculate the emission factor for an electricity system (Version 7.0, EB 100) and
Demonstration of additionality of small-scale project activities(Version 12.0,EB 99)

Please click following link for more information about the methodology and tool:
http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2. Applicability of methodologies and standardized baselines

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The Project is a grid connected renewable electricity generation project which meets all the applicability criteria stated in methodology ASM I.D (Version 18):

Applicability	Applicable? Yes/No	comment
This methodology is applicable to project activities that: (a) Install a Greenfield power plant; (b) Involve a capacity addition in (an) existing plant(s); (c) Involve a retrofit of (an) existing operating plant(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s).	Yes	The proposed CDM project is to install a Greenfield hydro power plant and power generation will be imported to grid.
Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: (a) The project activity is implemented in an existing reservoir with no change in the volume of reservoir; (b) The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m2; (c) 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.	No	There is no reservoir for the project.
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 co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	No	The proposed CDM project has only renewable components, and the installed capacity is 12MW, which is small scale.
Combined heat and power (co-generation) systems are not eligible under this category	No	The proposed CDM project is not a combined heat and power (co-

		generation) systems.
In the case of project activities that involve the capacity 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	No	The proposed CDM project does not involve the capacity addition of renewable energy generation units at an existing renewable power generation facility.
In the case of retrofit, rehabilitation or replacement, to qualify as a small-scale project, the total output of the retrofitted, rehabilitated or replacement power plant/unit shall not exceed the limit of 15 MW.	No	The proposed CDM project does not include retrofits, rehabilitations, replacements, or capacity additions.
In the case of landfill gas, waste gas, wastewater treatment and agro-industries projects, recovered methane emissions are eligible under a relevant Type III category. If the recovered methane is used for electricity generation for supply to a grid then the baseline for the electricity component shall be in accordance with procedure prescribed under this methodology. If the recovered methane is used for heat generation or cogeneration other applicable Type-I methodologies such as "AMS-I.C.: Thermal energy production with or without electricity" shall be explored.	No	The proposed CDM project is not landfill gas, waste gas, wastewater treatment and agro-industries project.
In case biomass is sourced from dedicated plantations, the applicability criteria in the tool "Project emissions from cultivation of biomass" shall apply.	No	The proposed CDM project is not biomass project.

Therefore, the methodology AMS-I.D.-Grid Connected Renewable Electricity Generation is applicable to the Project.

"Tool to calculate the emission factor for an electricity system" (Version 7.0) was adopted to estimate the emission factor of the project. According to the "Tool to calculate the emission factor for an electricity system", the applicability is as follows.

Applicability	Applicable? Yes/No	comment
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	Yes	The power generated by the project will be supplied to the regional grid consisting of Thailand Power Grid and the Lao Power Grid, and result in saving of electricity that would have been provided by the grid.
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, two sub-options under the step 2 of the tool are available to the project participants, i.e. option IIa and option IIb. If option IIa is chosen, the conditions specified in "Appendix 1: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	No	The proposed CDM project is a grid power plant, not a off-grid power plants.

In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	No	The proposed CDM project is located in Non-Annex I country-Lao PDR.
Under this tool, the value applied to the CO2 emission factor of biofuels is zero.	No	The proposed CDM project is not involve biofuels.

The applicability of "Demonstration of additionality of small-scale project activities(Version 12.0,EB 99)" is as follows

Applicability	Applicable? Yes/No	comment
The use of the methodological tool "Demonstration of additionality of small-scale project activities" is not mandatory for project participants when proposing new methodologies. Project participants and coordinating/managing entities may propose alternative methods to demonstrate additionality for consideration by the Executive Board.	Yes	The proposed project is a small-scale project whose installed capacity is 12MW(2*6MW).
Project participants and coordinating/managing entities may also apply "Tool for Demonstration of additionality of microscale project" as applicable.	No	The proposed project is not a microscale project, its installed capacity 12MW(2*6MW), which is more than 5MW.

The project is a run-of-the-river hydropower station. The installed capacity is 12MW(2*6MW), with annually 54.07 GWh power supplied to the power grid, which is small-scale(Type I- maximum output capacity equivalent of up to 15 megawatts).

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

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Spatial boundary

In accordance with AMS-I.D, 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"*. Project boundary is shown in diagram below:

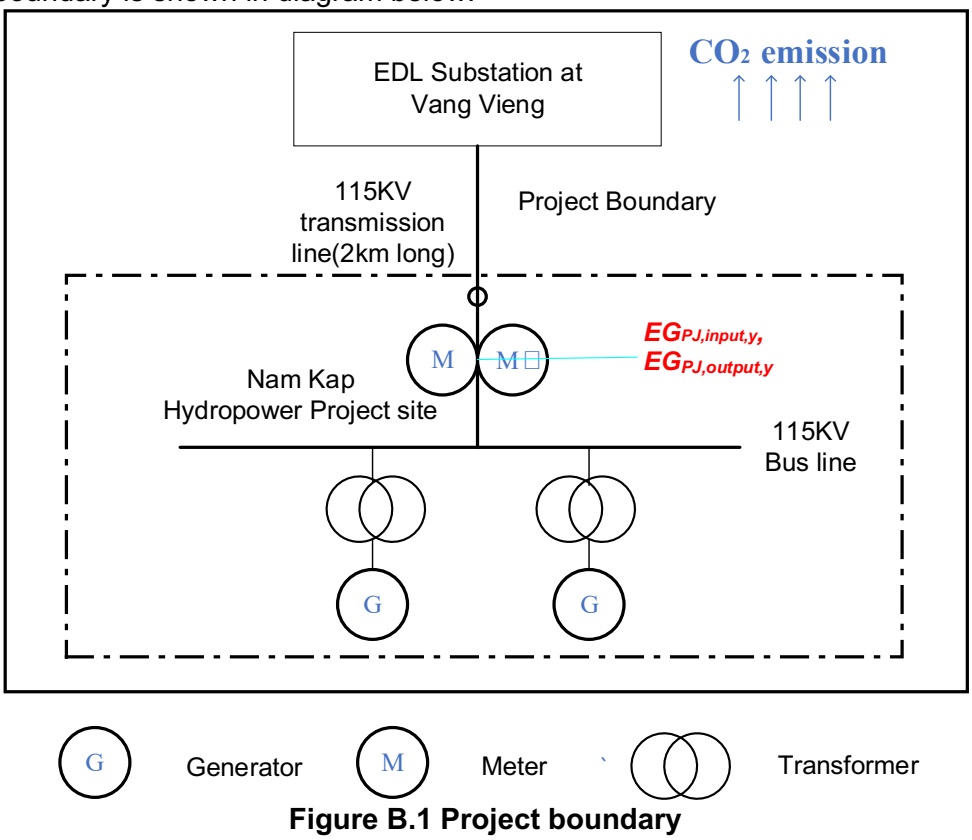

Figure B.1 Project boundary

The power generated by the proposed CDM project will be supplied to the Lao Power Grid, which connected with Thailand Power Grid through transmission lines. According to the "*Calculation for the emission factor for electricity generation in Lao PDR, 2010*" published by the Lao DNA, the regional grid consisting of Thailand Power Grid and the Lao Power Grid is adopted as the proposed CDM project boundary.

According to "*Tool to calculate the emission factor for an electricity system*", the project electricity system is defined as the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (i.e. the renewable power plant location) and that can be dispatched without significant transmission constraints. A connected electricity system is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

According to the tool mentioned above, there are no transmission constraints if any one of the following criteria is met:
i. In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of less than five per cent between the two electricity systems during 60 per cent or more of the hours of the year; or
ii. The transmission line is operated at 90 per cent or less of its rated capacity at least during 90 per cent of the hours of the year.

As demonstrated by the official document by Lao DNA mentioned above, for transmission lines between Thailand and Lao Power Grid, there is no spot market exists, so the criteria i. list above is not applicable. Furthermore the load of the transmission lines between Lao Power Grid and Thailand Power Grid is far below 50% of its rated capacity during all the year[2]. So, the electricity system does not have significant transmission constrain.

According to the Para 18 of the "*Tool to calculate the emission factor for an electricity system*": "*In addition, in cases involving international interconnection (i.e. transmission line is between different countries and the proposed CDM project electricity system covers national grids of interconnected countries) it should be further verified that there are no legal restrictions for international electricity exchange."*

The grid between Lao and Thailand kept enormous power exchange, and the power comparison of Laos export, import and domestic demand are listed below:

Table B.1 Power exchange between Lao and Thailand (Unit: GWh)

	2010	2009	2008
Lao power export to Thailand[3]	6,938.45	2,385.84	2,315.43
Domestic demand in Lao[4]	2,228.15	1,901.29	1,577.86
Lao power import from Thailand (EDL)[5]	1,042.12	1,081.19	772.8

[2] Information provided by EDL, regarding to the power load of the transmission lines between Laos and Thailand.

[3] EGAT Annual Report 2010, page 101 & Annual Report 2009, page 88, Electricity Generating Authority of Thailand.

[4] EDL Annual Report 2009, page 17, Electricite du Laos.

[5] EGAT Annual Report 2010, page 102 & Annual Report 2009, page 89, Electricity Generating Authority of Thailand.

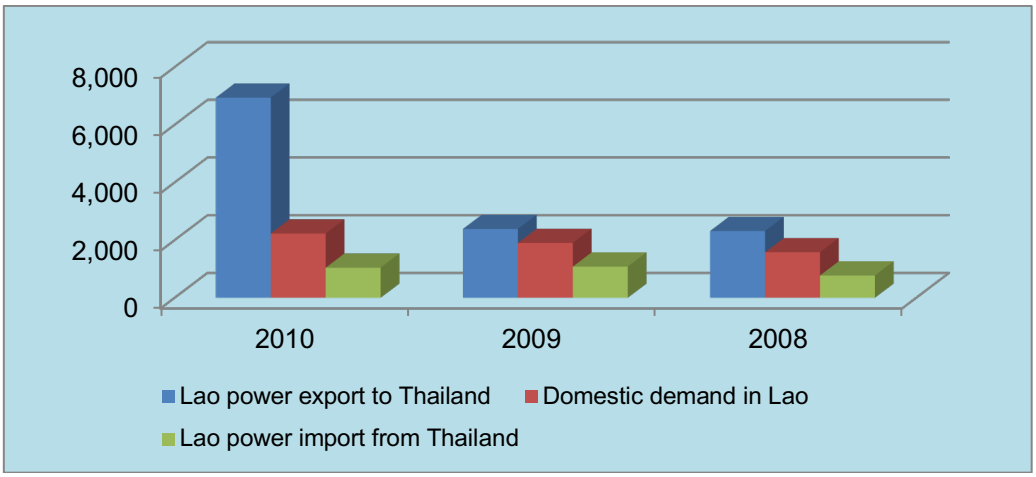

Figure B.2 Power exchange between Lao and Thailand (Unit: GWh)

The data listed above indicates the close relationship between the power system of Lao and Thailand. The Thai and Lao power system have kept intimately cooperation, and Thailand government promised that 7,000 MW power will be imported from Lao PDR during 2010 to 2015[6]. According to the MOU signed between Lao government and Thailand government, through the interconnection between the two countries, Lao power grid could sold the surplus energy to Thailand, and the deficits of Lao demand in rush hours can be covered by imports. Based on the above information, it could be concluded that there are no legal restrictions for international electricity exchange.

Based on the reasons listed above, it is shown that the most appropriate definition of the spatial extension of the proposed CDM project electricity system is a regional grid consisting of Thailand Power Grid and the Lao Power Grid.

Emission sources and gases

The greenhouse gases and emission sources included in or excluded from the proposed CDM project boundary are shown in the table below.

[6] http://uk.reuters.com/article/idUKBKK15938520071018

Table B.2 GHG emissions in Project boundary

Source		GHG	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the proposed CDM project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	For dry or flash steam geothermal power plants, emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	No	Not applicable to hydro power Project
		CH_4	No	
		N_2O	No	
	For binary geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam.	CO_2	No	Not applicable to hydro power Project
		CH_4	No	
		N_2O	No	
	For binary geothermal power plants, fugitive emissions of hydrocarbons such as n-butane and isopentane (working fluid) contained in the heat exchangers	CO_2	No	Not applicable to hydro power Project
		CH_4	No	
		N_2O	No	
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants.	CO_2	No	Not applicable to hydro power Project
		CH_4	No	
		N_2O	No	
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Minor emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source

B.4. Establishment and description of baseline scenario

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According to AMS-I.D., as a Greenfield hydropower Project, the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.

The proposed CDM project activity is the installation of a new grid-connected renewable power plant/unit, and is not a modification/retrofit of an existing plant/unit, therefore, the baseline scenario is provision of the equivalent amount of electricity generated by the power plants connected with the regional grid consisting of Thailand Power Grid and the Lao Power Grid, and the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "*Tool to calculate the emission factor for an electricity system*" (Version 7.0).

B.5. Demonstration of additionality

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Prior consideration of CDM

To overcome financial weakness, and unfavourable conditions that the project encounters, the project owner decided to seek CDM assistance after the project Feasibility Study Report has been completed by independent design institute.

Currently, the project has not started yet, the prior consideration form was submitted before the project start, CDM was seriously considered in the decision to implement the project activity.

The main Milestones in the Project implementation and CDM application summarized in the below table:

Table B.3 Timeline of the key events

Time	Event
Nov 2015	IEE was completed
Nov 2015	FSR was completed, and CER revenue has been taken into account
May 16th 2016	Got the FSR Approval
Jul 9th 2016	IEE was approved by GOL
Sep 13th 2016	Investment decision was made by the chairman of the board and the incentive of CDM is acknowledged as a key element of the project's profitability
Mar 11st 2017	Submitted the CDM Prior Consideration to EB
Mar 15th 2017 – Apr13th 2017	PDD started GSC
Apr 30th 2017	EPC Contract has been signed. (Starting date of CDM)
Jun 15th 2017	The project started construction.
Jan 1st 2020	Commission date (expectation)

As shown in above table, the CDM was seriously considered during the project implementation.

Additionality

According to Demonstration of additionality of small-scale project activities(Version 12.0,EB 99), Project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

a) Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions;
b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

The additionality assessment is based on the proposition that the project faces an investment barrier would prevents its implementation. As a small hydropower project located in poor mountainous area, the project faces many implementation complexities, which make it hardly financial attractive. The investment barrier represents the most prohibitive factor in implementing the project. Detailed analysis is shown as follow:

The insurmountable barrier for the implementation of the project is investment barrier. According to the "*Tool for the demonstration and assessment of additionality*" (Version 7.0.0) approved by EB, the additionality of the project is demonstrated and assessed through the following steps.

Step 0: Demonstration whether the proposed project activity is the first-of-its-kind

The proposed project activity is not the first-of-its-kind, proceed to Step 1.

Step 1. Identification of alternatives to the proposed CDM project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the proposed CDM project activity:

Plausible and credible alternatives available to the proposed CDM project that provide outputs or services comparable to the proposed CDM project activity include:

Alternative a): The proposed CDM project activity not undertaken as a CDM project activity;
Alternative b): Construction of a thermal power plant with equivalent installed capacity or annual electricity generation;
Alternative c): Construction of a power plant using other sources of renewable energy with equivalent amount of annual electricity generation;
Alternative d): Provision of an equivalent amount of annual power output by the grid into which the proposed CDM project is connected.

Alternative a) is in compliance with all applicable legal and regulatory requirements. But according to the investment analysis in step 2, this scenario is less attractive with low project IRR and is not realistic without CDM financing.

Alternative b) is not a realistic alternative. According to the Power System Development Plan for Lao PDR, there isn't an existing thermal power plant with the similar or larger power generation capacity with Nam Kap project in Lao yet, furthermore, at the proposed project site, there isn't any coal mine developed, the only way to obtain enough material is transport coal from other regions, and thus will significantly increase the cost in such a mountainous region.

Alternative c), other kinds of renewable energy technologies, such as wind, solar PV, geothermal, and biomass are possible grid-connected sources. However, according to the *Country Paper Rural Energy Development and Utilization*[7], these projects face varies barriers in awareness, finance, law and institution and technologies, etc. The other kinds of renewable energy technologies in Lao are not mature currently and lack of financial attractive to construct power plants with the similar power generation capacity with Nam Kap Hydropower project.

Alternative d) is in compliance with all applicable legal and regulatory requirements.

Outcome of Sub-step 1a: demonstrates that the identified realistic and credible alternative scenarios to the proposed CDM project activity are Alternatives a), d).

Sub-step 1b. Consistency with mandatory laws and regulations:

All the alternatives identified above are in compliance with applicable rules and regulations in Lao PDR.

Outcome of Step 1b: demonstrates that the identified realistic and credible alternative scenarios to the proposed CDM project activity are Alternatives a), d).

Step 2. Investment analysis

The purpose of this step is to determine whether the proposed CDM project activity is economically or financially less attractive than other alternatives without the revenue from the sale of certified emission reductions (CERs). The investment analysis was conducted in the following steps:

Sub-step 2a. Determine appropriate analysis method

The "*Tool for the Demonstration and Assessment of Additionality (Version 7.0.0)"* proposal three analysis methods which are:
(Option I) Simple cost analysis;
(Option II) Investment comparison analysis;
(Option III) Benchmark analysis;

[7] Prepared by Renewable Energy Technology Center, Technology Research Institute of Lao PDR,

Since the proposed CDM project will earn revenues not only from the CERs sales but also from electricity sales, the simple cost analysis method is not appropriate. Investment comparison analysis method is only applicable to projects whose alternatives are similar investment projects. The Alternative d) of the proposed CDM project is supply electricity by the regional grid rather than newly invested projects. Therefore, Option II is not appropriate. The proposed CDM project will use benchmark analysis method (Option III) based on the consideration that benchmark project IRR of the power sector is available.

Sub-step 2b. Option III. Apply benchmark Analysis

According to the "*Tool for the Demonstration and Assessment of Additionality (Version 7.0.0)"*, there are five options for discount rates and benchmarks determine:
a) Government bond rates, increased by a suitable risk premium to reflect private investment and/or the proposed CDM project type, as substantiated by an independent (financial) expert or documented by official publicly available financial data;
b) Estimates of the cost of financing and required return on capital (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned), based on bankers views and private equity investors/funds' required return on comparable projects;
c) A company internal benchmark (weighted average capital cost of the company), only in the particular case where the proposed CDM project activity can be implemented by the proposed CDM project participant, the specific financial/economic situation of the company undertaking the proposed CDM project activity can be considered. The proposed CDM project developers shall demonstrate that this benchmark has been consistently used in the past i.e. that project activities under similar conditions developed by the same company used the same benchmark;
d) Government/official approved benchmark where such benchmarks are used for investment decisions;
e) Any other indicators, if the proposed CDM project participants can demonstrate that the above Options are not applicable and their indicator is appropriately justified.

For this project, option a) was applied to determine the project IRR benchmark. The proposed CDM project adopted US dollar as the currency accounted and invested in Lao PDR, thus the benchmark is combined by the maturity rate of the 3-month US Treasury bill and the risk premium on lending of Laos which could respectively reflect the risk-free return of the currency adopted and the risk premium of the host country.

The average value of the 3-Month US Treasury Constant Maturity Rate[8] at the recent 20 years before the starting date (Apr 30th 1997 ~ Apr 29th 2017) 2.09% will be introduced to represents the risk free rate (nominal rate, consistent with the calculation of cash flow) for the following reasons:
i. There is no systematic government bond issue structure in Lao PDR;
ii. The project was accounted in U.S. dollar, and the 3-month U.S. Treasury rate is a widely accepted risk-free rate[9];
iii. The average value in the recent 20 years before the starting date was applied since the long term average value reduces the short term uncertainty and violation of the market.

Regarding the value of national risk premium, the data "Risk premium on lending (prime rate minus Treasury bill rate, %)" provided by World Bank[10] was applied. Risk premium on lending is the interest rate charged by banks on loans to prime private sector customers minus the "risk free" Treasury bill interest rate at which short-term government securities are issued or traded in the market. The data is proper to illustrate the "suitable risk premium to reflect private investment" in the host country stated in the *"Tool for the Demonstration and Assessment of Additionality (Version 7.0.0)"*. To reduce the short term uncertainty, the average risk premium of Lao PDR in the latest 5

[8] Website of the Federal Reserve Bank of St. Louis http://research.stlouisfed.org/fred2/series/DGS3MO?cid=47

[9] http://www.investopedia.com/terms/r/risk-freerate.asp#axzz1V9mGhc6k

[10] http://data.worldbank.org/indicator/FR.INR.RISK

years 12.69% was adopted (the risk premium of Lao PDR from 2006 to 2010 are 11.663%, 10.14%, 11.744%, 15.254% and 14.64% respectively).

So, the project IRR benchmark adopted equals the maturity rate of the 3-month US Treasury bill plus the Risk premium on lending in Lao PDR, the value is 14.78% (post-tax).

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

- Basic parameters for calculation of financial indicators

The financial index from FSR was used for project IRR analysis. FSR was completed by third party in November 2015 which is earlier than the project's start date. In FSR of Nam kap, tax (Including Business turnover tax, Minimum tax and Profit tax) and depreciation were not considered in the economic analysis, the project IRR without tax and depreciation according to FSR is 10.75%.

Considering the influence of tax and depreciate (index from Lao People's Democratic Republic On the Promulgation of the Tax Law), the value of project IRR is 9.47%[11], which is lower than FSR value.

From the above analysis, the FSR value is more conservative, which is used for the CDM Project's financial analysis and Critical value analysis, the main assumptions for the investment analysis are shown in Table below.

Table B.4 Basic parameters of the project

Basic parameters		Unit	Value	Source
Installed capacity		MW	12	FSR
Static investment		10^6 USD	21.85	FSR
Fluid Capital		10^6 USD	2.644	FSR
Annual net power supplied		GWh	54.070	FSR
The annual average energy		GWh	54.617	FSR
Electricity tariff	Basic Tariff	USD/KWh	0.0575	FSR
	Annual growth rate	%	1	FSR
Operation period		year	30	FSR
Construction period		year	3	FSR
Material fee		USD/kW	0.77	FSR
Staff		person	5.00	FSR
Staff annual salary		USD/person	7000	FSR
Repairing fee rate (accounts for static investment)		%	1.00	FSR
Fixed Assets Premium (accounts for static assets investment)		%	0.25	FSR
Franchise Resource Royalties (accounts for sales income)		%	1.00	FSR
Other cost		%	1.00	FSR

[11] The Business turnover tax, Minimum tax and Profit tax are considered, the rate of 5%, 0.25% and 15% are used in the project IRR recalculation according to the "Decree of the president of the Lao People's Democratic Republic On the Promulgation of the Tax Law".

Furthermore, Depreciate was also considered, for Structure and equipment, the following

	Depreciation years	Depreciation rate
Structure	20	5
Equipment	5	20

The analysis shows that without the revenue of CERs, the project IRR of the project will be 10.75% according to the FSR. Much lower than the project IRR benchmark 14.78%. The project is not financial attractive. However, the CDM revenues will help project overcome the investment barriers.

Sub-step 2d. Sensitivity analysis

The sensitivity analysis shows whether the conclusion regarding financial attractiveness is robust to reasonable variations in the critical assumptions. For the project, the most important parameters impacting the project IRR are:

- Fixed assets investment
- Annual O&M cost
- Electricity tariff
- Power supplied to the grid

In case of the ±10% variation range of the four parameters, the fluctuations of the project IRR (without CER revenue) are showing below:

Table B.5 Sensitive analysis of the project

Variation range / IRR / Parameters	-10%	-5%	0%	+5%	+10%
Fixed assets investment	11.90%	11.30%	10.75%	10.23%	9.76%
Annual O&M cost	10.88%	10.81%	10.75%	10.68%	10.62%
Electricity tariff	9.55%	10.16%	10.75%	11.33%	11.90%
Power supplied to the grid	9.55%	10.16%	10.75%	11.33%	11.90%

Figure B.3. Sensitive analysis

Based on the relationship shown above, we can find out that the project IRR that will decline accompany with the rise of the fixed assets investment and the annual O&M cost; and the project

IRR will rise accompany with the rise of the electricity tariff and the electricity supply. We can conclude from the above analysis that, even if ±10% variation range of the four parameters, the project IRR of the project still can't surpass the benchmark. However, the revenue from the CERs will greatly improve the financial feasibility of the project.

In conclusion, without the consideration of the revenue from CERs, the conclusion of the proposed CDM project activities lacks of commercial attraction is evidenced, so the specific project is in shortage of commercial attraction.

Based on the above analysis, the proposed CDM project IRR could reach the benchmark 14.78% if one of the following conditions can be achieved:

Table B.6. Conditions make the project IRR reach the benchmark

Parameters	Overall
Fixed assets investment	-29.40%
Annual O&M cost	-331.59%
Electricity tariff	36.53%
Power supplied to the grid	36.53%

However, none of these conditions can be achieved due to the following reasons:

1) Regarding the fixed assets investment

The parameters adopted from the FSR that finalized by the third party with abundant experiences in hydropower projects. The static investment estimated in the FSR is in line with local standards on engineering, procurement and construction. Through comparing with the first actual signed contract, the Contract Price is US$21,900,000, which is greater than static investment, thus it is unlikely to decrease the investment as much as 29.40%.

2) Regarding the annual O&M cost

O&M is not a sensitive parameter. In this project, even if the O&M decreased to zero, the project IRR is still lower than the benchmark. So it is unlikely to decrease the investment as much as 331.59%.

3) Regarding the electricty tariff

The Tariff adopted in the analysis is sourced from the FSR that finalized by the third party, and the base electricity tariff will be 0.0575 USD/kWh and will increased by 1% on an annual basis. And according to the Power Purchase Agreement signed between the proposed CDM project Owner, the base energy purchase price is 0.0575 USD/kWh (same as the FSR value) and escalate at one percent (1%) per annum in ten (10) year and keep steady five point fifty (6.35) UScent/kWh, thus the actual tariff after the 11^{th} year is lower than FSR value, so it is unlikely to increase by 36.53%.

4) Regarding the power supplied to the grid

The power supply is determined by the FSR author according to a relative long-term local hydrological data. There may exist fluctuations and uncertainty among the practical situation in each operational year regarding to the precipitation and runoff of the river, but the space of fluctuation would be limited. In addition, the operation hours of Nam Kap was compared to the five similar hydropower project (applicable output range as +/-50% of the design output or capacity of the proposed project activity,6~18MW), the value of operation hour is in the range of the maximum (5743,24) and the minimum (3539.29) of the similar hydropower projects, if Operation Hours of Nam Kap Hydropower Project rise by 36.53%, the data (6151.81) will go out of the range. So it is unlikely to deviate from the long-term hydrological data as much as 36.53% annually.

Table B.7. Operation Hour comparison of similar hydropower projects

Project Name	Capacity （MW)	Power(GWh)	Operation Hours
Nam Nga 2 Hydropower Project	14.5	62.59	4316.55
Nam Sana Hydropower Project	14	420.9	3539.29
Xe Namnoy 2 - Xe Katam 1 Hydropower Project	15	248.6	5533.33
Xenamnoy 1 Hydropower Project	14.8	411.53	5743.24
Nam Kap Hydropower Project	12	54.07	4505.83

In conclusion, without the consideration of the revenue from CERs, the conclusion of the proposed CDM project activities lacks of commercial attraction is evidenced, so the specific project is in shortage of commercial attraction.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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The Methodology AMS-I.D. is applied in the context of the proposed CDM project in the following four steps:

- **Step 1, calculate the proposed CDM project emissions;**
- **Step 2, calculate the baseline emissions;**
- **Step 3, calculate the proposed CDM project leakage;**
- **Step 4, calculate the emission reductions.**

Calculate the proposed CDM project emissions

According to Methodology, the proposed CDM project emissions shall be calculated by the following equation:

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

Where:

PE_y Project emissions in year *y* (tCO_2e/y);

$PE_{FF,y}$ Project emissions from fossil fuel consumption in year *y* (tCO_2/y);

$PE_{GP,y}$ Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year *y* (tCO_2e/y);

$PE_{HP,y}$ Project emissions from water reservoirs of hydro power plants in year *y* (tCO_2e/y);

For this project, does not involve the fossil fuel consumption and geothermal power, so $PE_{FF,y} = 0$, $PE_{GP,y} = 0$. For hydro power project activities that result in new reservoirs and hydro power project activities that result in the increase of existing reservoirs, project proponents shall account for project emissions, estimated as follows:

a) If the power density (*PD*) of power plant is greater than 4 W/m^2 and less than or equal to 10 W/m^2:

$$PE_{HP,y} = \frac{EF_{Res} \cdot TEG_y}{1000} \quad \text{(Equation B.2)}$$

Where:

$PE_{HP,y}$ Project emissions from water reservoirs (tCO_2e/y);

EF_{Res} Default emission factor for emissions from reservoirs, and the default value as per EB 23 is 90 kg CO_2e /MWh;

TEG_y Total electricity produced by the proposed CDM project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y*

(MWh);

b) If the power density (*PD*) of the power plant is greater than 10 W/ m^2

$$PE_{HP,y}=0 \quad \text{(Equation B.3)}$$

The PD of the proposed CDM project activity is calculated as follows:

$$PD=\frac{Cap_{PJ}-Cap_{BL}}{A_{PJ}-A_{BL}} \quad \text{(Equation B.4)}$$

Where:

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

There is no reservoir for the project, thus $PE_{HP,y}$= 0 tCO_2e/yr. Then PE_y=0 tCO_2e/yr.

Calculate the baseline emissions

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the proposed CDM project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$BE_y=EG_{PJ,y}\times EF_{grid,CM,y} \quad \text{(Equation B.5)}$$

Where:

BE_y	=	Baseline Emissions in year *y* (tCO_2/yr);
$EG_{PJ,y}$	=	Quantity of net electricity supplied 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 for grid connected power generation in year *y*;

According to Methodology, if the proposed CDM project activity is the installation of a new grid-connected renewable power plant/unit at a site where no renewable power plant was operated prior to the implementation of the proposed CDM project activity, then:

$$EG_{PJ,y}=EG_{PJ,facility,y} \quad \text{(Equation B.6)}$$

Calculate the Combined margin CO_2 emission factor

The emission coefficient (measured in tCO_2e/MWh) should be calculated in a transparent and conservative manner according to the procedures prescribed in the "*Tool to calculate the emission factor for an electricity system*" (Version 07.0).

The data used for calculation are from an official source (where available) and publicly available. The calculation processes are as follows:
STEP 1: Identify the relevant electricity system.

STEP 2: Choose whether to include off-grid power plants in the proposed CDM project electricity system.
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 (BM) emission factor;
STEP 6: Calculate the combined margin (CM) emissions factor.

STEP 1: Identify the relevant electricity system

The DNA of Lao has published a delineation[12] of the proposed CDM project electricity system and connected electricity systems, therefore these delineations are applied. The proposed CDM project will supply power to Lao Power Grid, which according to the delineation published by Lao DNA, is a part of the regional power grid consisted by Lao and Thailand power grid. Therefore, the relevant electricity system is the regional power grid including Lao Power Grid and Thailand Power Grid. And the **connected electricity system** is Malaysia, China and Vietnam Power Grid[13].

For the purpose of determining the operating margin emission factor, 0 tCO_2/MWh was applied as the emission factor(s) for net electricity imports from a connected electricity system.

STEP 2: Choose whether to include off-grid power plants in the proposed CDM project electricity system (optional)

According to "*Tool to calculate the emission factor for an electricity system*" (Version 07.0), there are two options to calculate the operating margin and build margin emission factor:
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.

Option I is chosen for operating margin and build margin emission factor calculation.

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

According to "*Tool to calculate the emission factor for an electricity system*" (Version 07.0), there are four methods for calculating the $EF_{grid, OM, y}$:
(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM

The method (d) average OM is selected.

$EF_{grid,OM-ave,y}$ is calculated using ex ante option: a 3-year generation-weighted average in 2010, 2009, 2008, without requirement to monitor and recalculate the emissions factor during the crediting period.

STEP 4: Calculate the operating margin emission factor according to the selected method

The average OM emission factor is calculated as the average emission rate of all power plants serving the grid, using the methodological guidance as described under Step 4 in the "Tool to calculate the emission factor for an electricity system" for the simple OM, but also including the low-cost / must-run power plants in all equations.

[12] See Calculation for the emission factor for electricity generation in Lao PDR, 2010, Lao DNA

[13] According to Electrical Power in Thailand 2008, 2009, 2010, Thailand DEDE, the Thailand import power from Lao PDR and Malaysia. Lao is considered as part of the project electricity system, and Malaysia is considered as the connected electricity system. Vietnam and China are also considered as connected electricity system for the power supply to Lao according to the Annual Repot 2012 by the Lao Power Grid Electric du Lao (EDL).

According to *Tool to calculate the emission factor for an electricity system*, there are two options based on different data for calculating average OM:
Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or
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 proposed CDM project electricity system.

The necessary data for Option A is not available, so Option B can be used.

Under this option, the average OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, including low-cost/must-run power plants/units, and based on the fuel type(s) and total fuel consumption of the proposed CDM project electricity system, as follows:

$$EF_{grid,OM-ave,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y} \quad \text{(Equation B.7)}$$

Where:

$EF_{grid,OM-ave,y}$	Average operating margin CO_2 emission factor in year *y* (tCO_2/MWh);
$FC_{i,y}$	Amount of fossil fuel type *i* consumed in the proposed CDM 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 *y* (GJ / mass or volume unit);
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ);
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, including low-cost/must-run power plants/units, in year *y* (MWh);
i	All fossil fuel types combusted in power sources in project electricity system in year *y*;
y	The data available in the most recent 3 years;

According to the *Tool to calculate the emission factor for an electricity system*, electricity imports from the connected electricity systems $EG_{import,y}$ are included in the EG_y.

The detailed calculating procedures please refer to Appendix 4 of the PDD.

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

To calculate the build margin (BM) emission factor, the data for determine the sample group of power units *m* about the most recently units in the electricity system is needed. However, as an international project system, it's difficult to obtain the information for all the units in both Lao and Thailand (power generation data, commissioning date, and the fuel consumption). The data requirements for the application for calculate the build margin (BM) emission factor cannot be met.

As the Simplified CM is adopted in the step 6, the weighting of build margin emissions factor is 0.

STEP 6: Calculate the combined margin (CM) emissions factor

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:
(a) Weighted average CM; or
(b) Simplified CM.

According to "*Tool to calculate the emission factor for an electricity system"*, the simplified CM can be used if:

(a) The proposed CDM project activity is located in: (i) a Least Developed Country (LDC); or in (ii) a country with less than 10 registered CDM projects at the starting date of validation; or (iii) a Small Island Developing States (SIDS); and
(b) The data requirements for the application of Step 5 above cannot be met.

Lao is a Least Developed Country, therefore the criteria (a) is met; and also as mentioned in step 5, the data requirements for the application for calculate the build margin (BM) emission factor is not available, therefore the criteria (b) is also met.

The Simplified CM method is calculated as follow:

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y} \quad \text{(Equation B.8)}$$

Where:

$EF_{grid,CM,y}$	Combined margin CO_2 emission factor in year *y* (tCO_2/MWh);
$EF_{grid,BM,y}$	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 emission factor (%);
w_{BM}	Weighting of build margin emission factor (%);

Where, w_{BM}= 0, w_{OM}= 1.

Thus $EF_{CO2,grid,y} = EF_{grid,CM,y}$ =0.5595 tCO_2/MWh.

Calculate the proposed CDM project leakage

No leakage emissions are considered.

Calculate the emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{(Equation B.9)}$$

Where:

ER_y	Emission reduction in year *y* (tCO_2e/y);
BE_y	Baseline emission in year *y* (tCO_2e/y);
PE_y	Project emission in year *y* (tCO_2e/y).

B.6.2. Data and parameters fixed ex ante

>>

Data/Parameter	$FC_{i,y}$
Data unit	mass or volume unit of the fuel *i*
Description	Amount of fossil fuel type *i* consumed in the proposed CDM project electricity system in year *y* (mass or volume unit)
Source of data	*Calculation for the emission factor for electricity generation in Lao PDR, 2010*
Value(s) applied	Refer to Appendix 4 for details.
Choice of data or measurement methods and procedures	Data used are from Thailand DNA.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$NCV_{i,y}$
Unit	kJ/kg or kJ/m^3
Description	The net calorific value (energy content) per mass or volume unit of fuel *i* in year *y.*
Source of data	*Electric Power in Thailand 2010*
Value(s) applied	Refer to Appendix 4 for details.
Choice of data or Measurement methods and procedures	Data used are from Thailand authorities, DEDE.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$EF_{CO2, i, y}$
Unit	tCO_2/TJ
Description	The CO_2 emission factor per unit of fuel i in year y
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4
Value(s) applied	Refer to Appendix 4 for details.
Choice of data or Measurement methods and procedures	No specific local value available, the value form IPCC 2006, Guidelines for National Greenhouse Gas Inventories was adopted.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	EG_y
Unit	GWh
Description	Net electricity generated and delivered to the grid by all power sources serving the system, including low-cost/must-run power plants/units, in year y.
Source of data	Calculation for the emission factor for electricity generation in Lao PDR, 2010
Value(s) applied	Refer to Appendix 4 for details.
Choice of data or Measurement methods and procedures	Data used are from Thailand DNA, TGO.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$EG_{import,y}$
Unit	MWh
Description	The electricity(MWh) imported from Malaysia, China and Vietnam Power Grid in year y.
Source of data	Electricity report by EGAT (2010, 2009, 2008) EDL Annual Report 2012
Value(s) applied	Refer to Appendix 4 for details.
Choice of data or Measurement methods and procedures	Data used are from Thailand authorities, EGAT.
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

Project Emission (PE)

$PE_y = 0$

Baseline Emission (BE)

According to section B.6.1, in first crediting period, the baseline emission factor of the proposed CDM project:

$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$ =0.55950 tCO_2e/MWh.

The baseline emission of the proposed CDM project:

$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$ = 54,070 ×0.55950=30,252 tCO_2e

Project Leakage (PL)

No leakage emissions are considered.

Emission Reductions (ER)

$ER_y = BE_y - PE_y$ = 30,252 – 0 = 30,252 tCO_2e

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

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Year	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage (tCO_2e)	Emission reductions (tCO_2e)
01/01/2020-31/12/2020	30,252	0	0	30,252
01/01/2021-31/12/2021	30,252	0	0	30,252
01/01/2022-31/12/2022	30,252	0	0	30,252
01/01/2023-31/12/2023	30,252	0	0	30,252
01/01/2024-31/12/2024	30,252	0	0	30,252
01/01/2025-31/12/2025	30,252	0	0	30,252
01/01/2026-31/12/2026	30,252	0	0	30,252
Total	211,764	0	0	211,764
Total number of crediting years	7			
Annual average over the crediting period	30,252	0	0	30,252

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

>>

Data/Parameter	$EG_{PJ,facility,y}$
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y
Source of data	Electricity meter(s)

Value(s) applied	$EG_{PJ,facility,y} = EG_{PJ,output,y} - EG_{PJ,input,y}$
Measurement methods and procedures	This parameter should be monitored using bi-directional energy meter In case it is calculated then the following parameters shall be measured: (a) The quantity of electricity supplied by the project plant/unit to the grid; and (b) The quantity of electricity delivered to the project plant/unit from the grid
Monitoring frequency	Continuous monitoring, and monthly recording
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$EG_{PJ,output,y}$
Data unit	MWh
Description	Electricity supplied by the proposed CDM project to the grid in year y
Source of data	Measured by meters M and M'
Value(s) applied	54,070
Measurement methods and procedures	This parameter should be either monitored using bi-directional energy meter, the quantity of electricity supplied by the project plant/unit to the grid shall be measured.
Monitoring frequency	Continuous measurement and monthly recording
QA/QC procedures	According to the recommendation by the manufacturer or the regulations of the grid company, meters will be calibrated periodically. Data measured by meters will be cross-checked with the record document confirmed by EDL.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$EG_{PJ,input,y}$
Data unit	MWh
Description	The electricity used by the proposed CDM project and input from the grid in year y
Source of data	Measured by meters M and M'
Value(s) applied	0 MWh for ex-ante calculation
Measurement methods and procedures	This parameter should be monitored using bi-directional energy meter, the quantity of electricity delivered to the project plant/unit from the grid shall be measured.
Monitoring frequency	Continuous measurement and monthly recording
QA/QC procedures	According to the recommendation by the manufacturer or the regulations of the grid company, meters will be calibrated periodically. Data measured by meters will be cross-checked with the record document confirmed by EDL.
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.7.2. Sampling plan

>>

The data and parameters monitored in section B.7.1 above are not determined by a sampling approach.

B.7.3. Other elements of monitoring plan

>>

The purpose of the monitoring plan is to ensure that the monitoring and calculation of emission reductions of the proposed CDM project within the crediting period is complete, consistent, clear and accurate. The plan will be implemented by the proposed CDM project owner with the support of the grid corporation.

Monitoring organization

The monitoring process will be carried out and responsibility by the proposed CDM project owner. A monitoring panel will be established by the plant managers to be in charge of monitoring the data and information relating to the calculation of emission reductions with the cooperation of the Technical and Financial Department. A CDM manager will be assigned full charge the monitoring works. The operation and management structure is shown below:

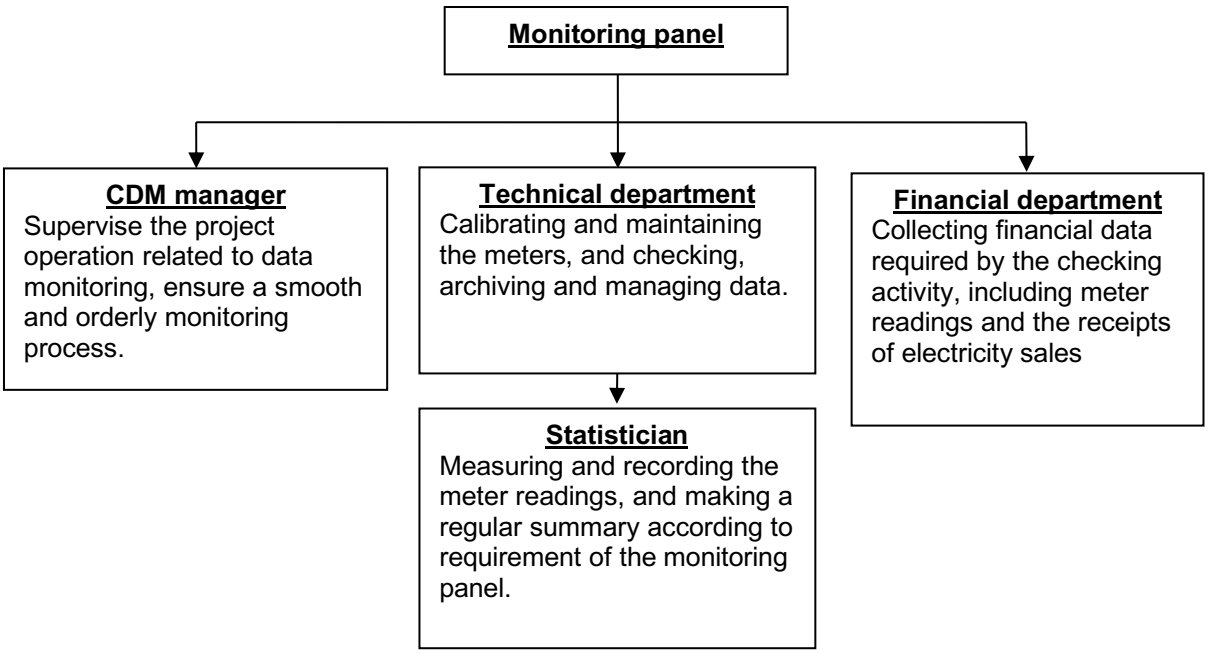

Figure B.4. Organization structure of the monitoring activity

Monitoring apparatus and installation:

The power generated by the two 6MW generators will be supplied to transformer substation through a 115 kV single-circuit transmission line to Lao Power Grid. According to the Power Purchase Agreement, two meters will be installed to monitor the input/output power. The meters M will be the main meter, installed at the grid access points, to monitoring the input/output electricity at the grid side. The meters M' will be the backup meter for M, respectively, parallel combined with M. When there is anything wrong with the main meter, the backup meter will be adopted. The accuracy of all meters will be not less than 0.5s.

The monitoring diagram is as following:

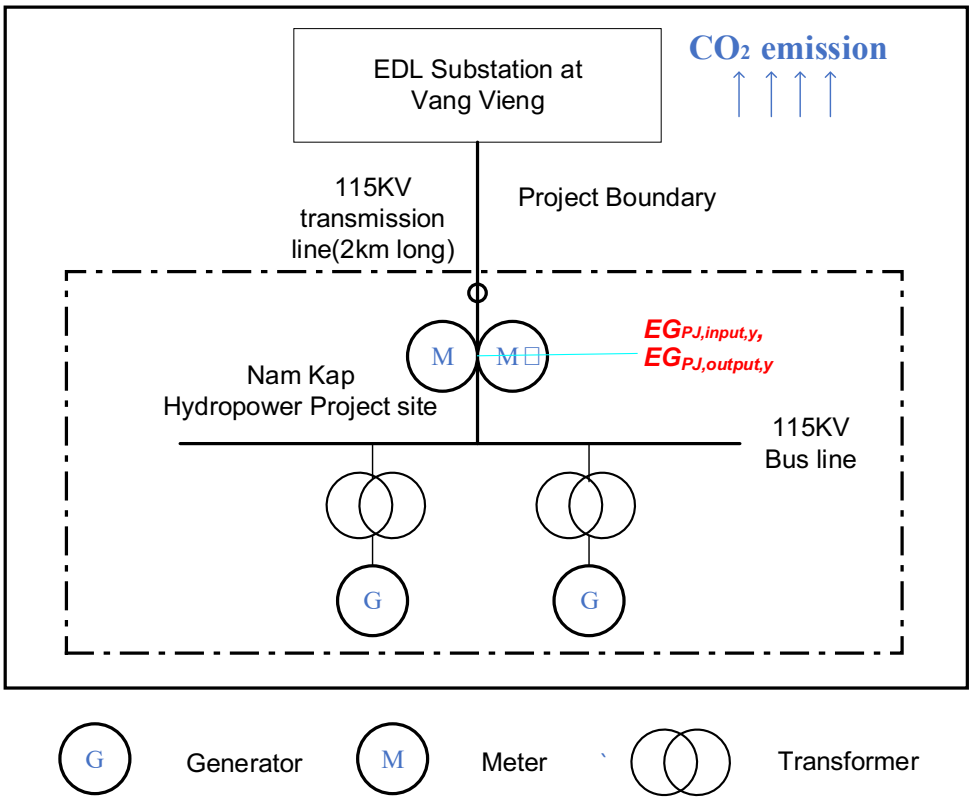

Figure B.5 Monitoring diagram

The meters will be installed in accordance with EDL regulations. Before the operation of the proposed CDM project, the metering equipment will be clarified and examined by the proposed CDM project owner and the power grid company according to the above regulation.

Data collection:

The specific steps for data collection and reporting are listed below:

a) During the crediting period, both the grid company and the proposed CDM project owner will record the values displayed by the main meter.
b) Simultaneously to step a), the proposed CDM project owner will both record the values displayed by the backup meters.
c) The meters will be calibrated according to the relevant regulation and request of EDL.
d) The main meter's readings will be cross-checked with record document confirmed by EDL.
e) The proposed CDM project owner and the grid company will record both output and input power readings from the main meter. These data will be used to calculate the amount of net electricity delivered to the grid.
f) The proposed CDM project owner will be responsible of providing copies of record document confirmed by EDL to the DOE for verification.

If the reading of the main meter in a certain month is inaccurate and beyond the allowable error or the meter doesn't work normally, the grid-connected power generation shall be determined by following measures:

a) Read the data of the backup meters.
b) If the backup meter's data is not so accurate as to be accepted, or the practice is not standardized, the proposed CDM project owner and the grid corporation should jointly make a reasonable and conservative estimation method which can be supported by sufficient evidence and proved to be reasonable and conservative when verified by DOE.
c) If the proposed CDM project owner and the grid corporation don't agree on an estimated method, arbitration will be conducted according the procedures set by the agreement to work out an estimation method.

Calibration

Calibration of Meters & Metering should be implemented according to relevant standards(IEC 62053-22/62053-23) and rules accepted by the grid company EDL. After the examination, the meters should be sealed. The lift of the seals requires the presence of both the proposed CDM project owner and the grid company. One party must not lift the seals or fiddle with the meters without the presence of the other party.

All the meters installed shall be tested by a qualified metering verification institution commissioned jointly by the proposed CDM project owner and the grid company within 10 days after:

1) Detection of a difference larger than the allowable error in the readings of both meters;
2) The repair of all or part of meter caused by the failure of one or more parts to operated in accordance with the specifications.

Data management system

Physical document such as the plant electrical wiring diagram will be gathered with this monitoring plan in a single place. In order to facilitate auditors' access to project documents, the proposed CDM project materials and monitoring results will be indexed. All paper-based information will be stored by the technical department of the proposed CDM project owner and all the material will have a copy for backup. All data, including calibration records, will be kept until 2 years after the end of the total crediting period.

Monitoring Report

During the crediting period, at the end of each year, the monitoring officer shall produce a monitoring report covering the past monitoring period. The report shall be transmitted to the General Manager who will check the data and issue a final monitoring report in the name of the proposed CDM projects participants. Once the final report is issued, it will be submitted to the DOE for verification.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
30/04/2017 (Signed the EPC Contract)

C.2. Expected operational lifetime of project activity

>>
30 years 0 month

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable crediting period（the first crediting period）

C.3.2. Start date of crediting period

>>
01/01/2020 or registration date, which is later

C.3.3. Duration of crediting period

>>
7 years 0 month

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

According to the Initial Environmental Examination report, environmental impacts caused by the project and the corresponding measures adopted by the project owner for mitigation are as following:

Construction Phase

Wastewater

The waste water is not allowed to be discharged into River directly in order to protect the water quality. The wastewater generated from disturbed, erosion prone land (i.e. construction camps, quarries, borrow pits and spoil dumps) will be treated employing the following mitigation measures according to the IEE report:

- Dirty water from erosion-prone land will be collected in interception channels and, if necessary, directed to sedimentation ponds, prior to being released to the environment;
- Septic sanitation facilities will be provided to construction and camp areas. No untreated human waste is allowed to enter any watercourse to affect water quality, aquatic environments and human health.
- All hydrocarbons (e.g. fuels and lubricants) and chemical reagents will be stored in safe places, fully bundled areas constructed and managed in accordance with relevant International Standards and Material Safety Data Sheets. Oil, fuel and lubricant storage areas should be located well away from any water courses. Project Developer will ensure that containers of reagents and drums of used oil or grease are stored under cover at all times;
- Potentially oil runoff from areas such as vehicle maintenance bays, equipment lay down areas, or refuelling stations will be contained by perimeter bundling or interception drains. Oil runoff will be directed through oil/water separators prior to discharge to the environment. Oil/water separators will be regularly cleaned and maintained.

Exhaust gases and dust

Exhaust gases resulting from vehicles, construction equipments and the dust generating from the construction activities is the greatest threaten of air quality. Dustproof measures are employed including watering and dust collecting, wet construction method will be used to minimize the negative impact and those construction equipment and vehicles in compliance with relevant sanitary regulations will be selected and properly conserved. Furthermore, dustproof respirator will be applied to protect the respiratory tract of the workers on site who are granted to be the main casualties. Attribute to the methods mentioned above, the negative impact on air quality is confined into the construction site during the construction period and can be neglected.

Solid and Liquid Waste

Waste management procedures will be based on the following hierarchy (in decreasing order of preference): (i) Minimize the waste production and maximize waste recycling and reuse; and (ii) Promote safe waste disposal.

To minimize waste production, a lot of mitigation measures will be taken including maximizing the efficiency of all on-site activities, supplying products with less waste produced and using no-hazardous materials. Project owner will educate staff, contractors to minimize litter generation and procedures will be established for segregating different types of waste at the location where they are generated to maximize the recovery of recyclables.

Noise and vibration

The area of construction, including quarries should have restricted working hours, including restricted times for above ground blasting. Construction workers exposed to noise levels of 70-80 dB or more than will be provided with adequate hearing protection, in accordance with the requirements of the health and safety plan. The exhaust and radiator silencers will be fitted to construction equipment, in particular, trucks and loaders. Construction activities and use of heavy vehicles will be minimized during night time. Emissions from reversing alarms may be regulated to reduce intrusiveness, particularly at night.

Impacts on ecosystem

Soil and water erosion might be induced attribute to slope exploration, earth-and-rock excavation, and the utilization of dumpsites. Rehabilitation of vegetation and other technique methods will be conducted to minimize the negative impact once the construction activities completed.

There seems to be no land acquisition involved with the project and no resettlement either, the soil is poor with low coverage rate of vegetation. Therefore, the induced ecosystem loss is minimum.

No cultural relic, mineral or protected plant were identified during the environment survey, and no extinction of plant will be induced. Hence, the impact to local ecosystem attribute to the transformation of land use is insignificant.

As the construction site is far away from nearest village, the proposed project will not result in any displacement of residents and inundation of houses.

Operation Phase

Waste water

The wastewater mainly generated from the permanent staffs during the operation phase is not allowed to be fed into the river directly. It is designed that the domestic sewage should be disposed using the advanced integrated treatment equipment to minimize the impacts on local environment.

Water quality and quantity

Clearance of head pond is one of the procedures that the project developer will be taken before head pond being filled in order to secure the operating safety that might be influenced by the trees, waste and etc. to be submerged. The project owner will closely coordinate with Provincial Agriculture and Forestry Office (PAFO) and District Agriculture and Forestry Office (DAFO) to undertake the head pond clearance.

And attribute to the river-type characteristics, the hydrological feature such as the precipitation, temperature and etc. will not alter obviously. Furthermore, the minimum water release will be not less than the natural flow in the dry season to maintain the eco-system.

In conclusion, environmental impacts arising from the Project are considered insignificant.

D.2. Environmental impact assessment

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Both the Host Party and the proposed CDM project participant regard that the proposed project will not bring significant negative impact to the environment. The proposed CDM project could be put into commencement only after the approval of the IEE by local Environmental Protection Administration. The IEE was approved in Jul. 9th, 2016.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

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According to the Initial Enviromental Examination designed by SC Consultants Sole Co., LTD, Coordination with local people in the project area for development small hydropower Nam Kap, in Longsan district has started since November 2015, especially village heads and villagers around the area.

Most of people, the public participant to project, are interested in the location of dam project, the project development impacts, the project's information, project planning, environmental impact from project development and compensation for Project Affected Persons (PAPs).

Some recommendations and suggestions for the project implementation are:
Construction of project should appliance to Lao law and regulation and has to be accepted from local people.

Project implementation should propose to related stakeholders such as province, district and villages, PAPs.

The studies' result should be report through villages, district and province accordingly.

Public participation to the project implementation should be organized from steps as below:

To coordinate the relevant stakeholders, villages, district and province visiting project area.

Interview form has to have included place of village, population, economic structure, infrastructure, social service, village asset and other recommendations.

To held consultant meeting for the impact of project development and invite relevant participants such as local people, PAPs, village, village cluster, district and province to listen and discuss of the impact from the project.

Figure E.1 Photo of public involvement of Nam Kap HPP

Meeting with concern line agencies of Longsan District. The purpose is to disseminate the information from the project and seeking advice and cooperation for field study.

Figure E.2. Investigation with local villagers

E.2. Summary of comments received

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In order to consult the public's opinions and suggestions about the project, stakeholders were invited to carry out a consultation meeting through local government and bulletins. The stakeholder meeting was hold in 15/03/2017, 48 stakeholders including representative of government officials at the Longsan district and 48 questionnaires were recieved. The summary of the questionnaires are as follows:

1) 91.7% of the respondents agree with the construction of the project, 8.3% of them don't care with the project, and 0% of the respondents disagree with the construction of the project.

2) There are 85.4% of the respondents consider the implement of the project have positive influence on local economic development, and 14.6% of the respondents consider the implement of the project have no influence on local economic development, and 0% of the respondents consider the implement of the project have negative influence on local economic development.

3) There are 83.3% of the respondents consider the implement of the project can improve the live quality of local residents, 16.7% of the respondents consider the implement of the project have no influence on local residents' livelihood, and 0% of the respondents consider the implement of the project will reduce local residents' livelihood.

4) There are 83.3% of the respondents consider the implement of the project could improve local employment, 0% of the respondents consider the implement of the project will reduce local employment opportunities, 16.7% of the respondents consider the implement of the project have no influence on local employment.

5) When asked about the impacts on the local environment, 20.8% of the respondents worry about the dust produced during the project construction, 25% of the respondents worry about the effect of noise, 33.3% of the respondents worry about the soil and water conservation problem, 12.5% of the respondents worry about the effect of solid wastes, and 8.3% of the respondents worry about the effect to the ecological environment;

6) 29.2% of the respondents consider the construction of the project will improve local environment condition, 29.2% of the respondents consider the construction of the project have no influence to local environment, 41.7% of the respondents consider the construction of the project may bring some problems, but the problems can be mitigated or controlled after environmental protection measures adopted, 0% of the respondents consider the construction of the project will reduce local environment condition.

The comments received from the stakeholders are summary as follows:

1) Hope the construction of the dam not impact the water use of the downstream residents.

2) Hope the project owner could introduce advanced agricultural technologies to the local villagers and improve their living standard.
3) Hope the construction of the project could improve local power supply situation.
4) Local transportation condition is poor, hope the project could help improve the road construction.
5) Hope the project construction could provide working chance to local residents.

E.3. Consideration of comments received

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The project does not involve resettlements. Considerations on the comments by the stakeholders are listed as follow:

1) The minimum flow will be released to maintain the eco-system and meet demand for irrigation in the downstream.
2) The project owner will donate money to the appointed Agricultural Development Fund, professional staff will introduce agricultural technologies to the villagers.
3) The construction of the project will improve local electricity transmission system, promote the electrification progress. Furthermore, the project owner will cooperate with the telecommunication company, provide electricity power to the communication station and thus promote local communication system development.
4) During the project construction period, the project owner will improve local road condition to transport the equipments. The project owner will also donate money to government for the national road construction alone the project site, which will greatly improve local transportation condition.
5) During the project construction period, plenty of working chances will provided to local residents. And during the operation period, some long-term position will provided to local people.

SECTION F. Approval and authorization

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The Letter of approval from Lao DNA was obtained.

Appendix 1. Contact information of project participants

Organization name	PHONGSUBTHAVY Group
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Website	
Contact person	Renat Heuberger

Appendix 2. Affirmation regarding public funding

No public funding from parties included in UNFCCC Annex I is available to the proposed CDM project activity.

Appendix 3. Applicability of methodologies and standardized baselines

Please refer to the Section B.1 of the PDD.

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

Table 1 Net electricity generated and delivered to the grid by all power sources serving the system (GWh)

Year	2010	2009	2008
Power generation by EDL owned power plants	1,552.73	1,655.91	1,777.57
Power generation by IPP located in Laos	7,329.69	2,135.32	1,938.01
Power generation in Thailand	152,913.56	142,697.75	142,330.52
Sum up	**161,795.98**	**146,488.98**	**146,046.10**

Sources from:

- EDL Annual Report 2012, 2010, 2009, Electricite du Laos;
- Electric Power in Thailand 2010, 2009, 2008, Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand;
- Electricity Statistic Annual Report 2010, Electricity Generating Authority of Thailand.

Table 2 Power import from the connected system (GWh)

Year	2010	2009	2008
Malaysia	160.31	92.68	470.67
Vietnam	31.81	25.39	22.59
China	77.02	21.58	17.78
Sum up	**269.14**	**139.65**	**511.04**

Sources from:

- Electricity Statistic Annual Report 2010, 2009, 2008, Electricity Generating Authority of Thailand.
- EDL Annual Report 2012, Electricite du Laos.

Table 3 Quantity of GHG emission by all power sources serving the system

Fuel Type	Fuel Consumption		Fuel Specific EF	Net Calorific Value	GHG emission
	$FC_{i,y}$		$EF_{CO2,m,i,y}$	$NCV_{i,y}$	$FC_{i,y}*EF_{CO2,m,i,y}*NCV_{i,y}/10^6$
	Unit	FC/Unit	tCO_2/TJ	MJ/Unit	tCO_2
2010					
Natural Gas	scf.	1,073,084,673,019	54.3	1.02	59,433,868
Lignite	ton	16,043,174	90.9	10470	15,268,658
Bituminous	ton	5,502,160	89.5	26370	12,985,730
Bunker	liter	233,229,746	75.5	39.77	700,304
Diesel	liter	24,026,558	72.6	36.42	63,528
2009					
Natural Gas	scf.	968,924,717,809	54.3	1.02	53,664,864
Lignite	ton	15,818,265	90.9	10470	15,054,607
Bituminous	ton	5,486,248	89.5	26370	12,948,176
Bunker	liter	158,017,445	75.5	39.77	474,469
Diesel	liter	13,825,937	72.6	36.42	36,557
2008					
Natural Gas	scf.	977,016,893,281	54.3	1.02	54,113,058
Lignite	ton	16,407,465	90.9	10470	15,615,362
Bituminous	ton	5,578,567	89.5	26370	13,166,060
Bunker	liter	350,209,394	75.5	39.77	1,051,551
Diesel	liter	51,941,958	72.6	36.42	137,339

Sources from:

- Electricity Statistic Annual Report 2010, Electricity Generating Authority of Thailand.
- IPCC 2006, Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4.
- Electric Power in Thailand 2010, Energy Content of Fuel, Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand.

$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$ = 1×0.5595 = 0.5595 tCO_2e/MWh.

Based on the equation and above data, the $EF_{grid,OM\text{-}ave,y}$ = 0.5595 tCO_2/MWh

Appendix 5. Further background information on monitoring plan

Please refer to the Section B.7 of the PDD.

Appendix 6. Summary report of comments received from local stakeholders

Please refer to the Section E.2. of the PDD.

Appendix 7. Summary of post-registration changes

Document information

Version	*Date*	*Description*
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; Editorial improvement.
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the proposed CDM project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the proposed CDM 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 proposed CDM 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 proposed CDM 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.

Version	*Date*	*Description*

Decision Class: Regulatory
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