Project design document form for CDM project activities

(Version 06.0)

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 Pha Gnai Hydropower Project
Version number of the PDD	2.1
Completion date of the PDD	03/11/2015
Project participant(s)	Nam Pha Gnai Hydropower Co., Ltd. Swiss Carbon Assets Limited
Host Party	Lao PDR
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	Sectoral Scope 1: Energy Industries. Baseline methodology: ACM0002 Grid-connected electricity generation from renewable sources
Estimated amount of annual average GHG emission reductions	62,184 t CO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Nam Pha Gnai Hydropower Project (hereafter referred to as the "the project") is located in Xaysomboun District, Vientiane Province, Lao PDR, developed by Nam Pha Gnai Hydropower Project Co., Ltd.

The project is a run-of-the-river hydropower station, at the downstream of the planned Nam Ngum 3 station. For the upstream Nam Ngum 3 hydropower project (hereinafter referred to as "NN3 project"), the installed capacity is 440MW, which will be in operation on 1 Jan. 2020. The installed capacity of the project is 19.2MW (7.4MW+7.4MW+4.4MW), the estimated power supplied to the power grid will be 130GWh (before year 2020) and 86GWh (after year 2020).

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 62,184 t CO_2e per year during the first crediting period.

As a renewable energy project, the 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;
- 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, promote the sustainable development in this region and slow down the increasing trend of GHG emissions.

A.2. Location of project activity

A.2.1. Host Party

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Lao PDR

A.2.2. Region/State/Province etc.

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Vientiane Province

A.2.3. City/Town/Community etc.

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Xaysomboun District

A.2.4. Physical/Geographical location

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The Project site is located at located in Xaysomboun District, Vientiane Province, Lao PDR. The approximate coordinates of the project site (Weir) is: 19.009331°N, 102.872314°E.

Figure A.1 Show the location of the project:

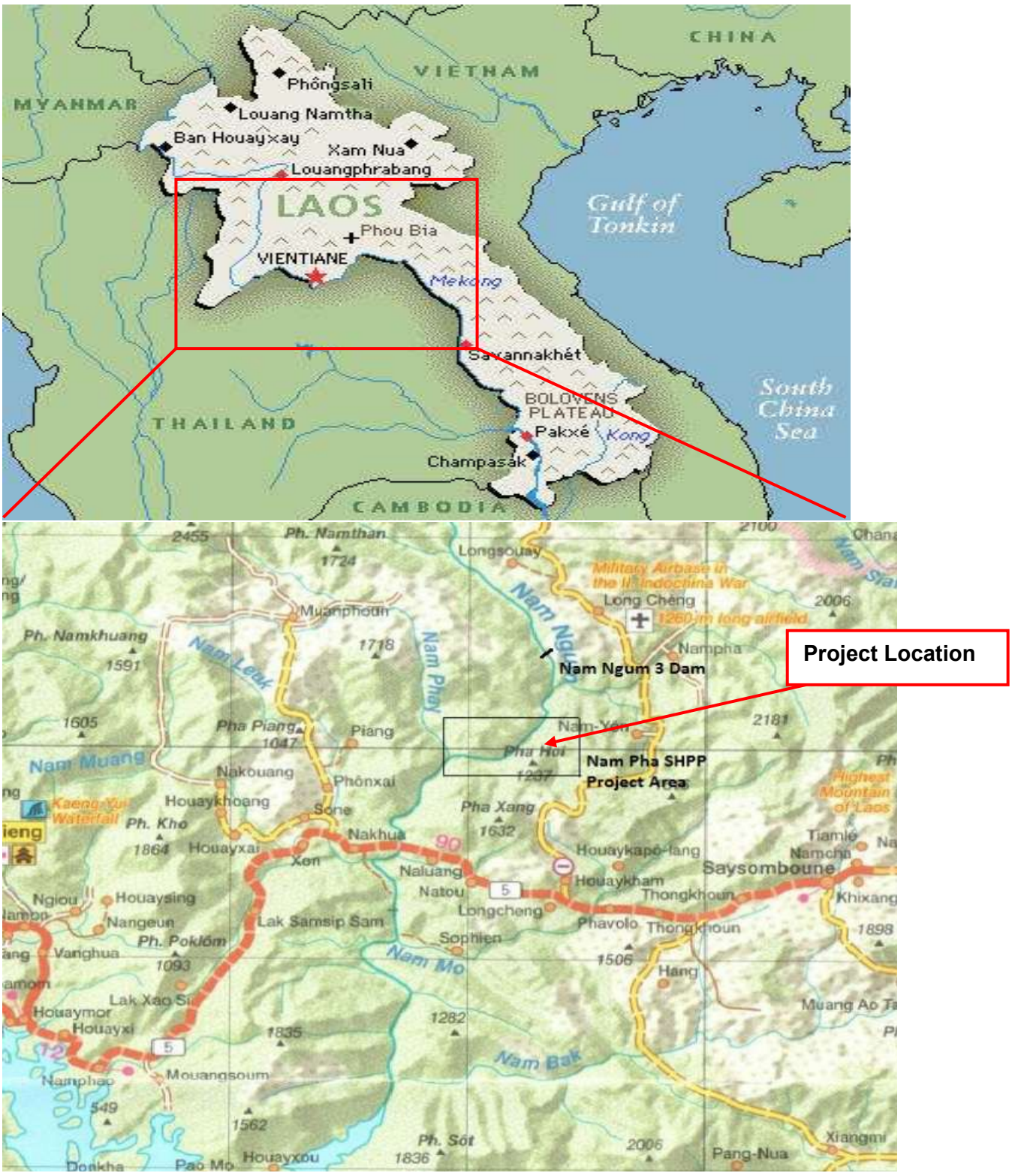

Figure A.1. Location of the project

A.3. Technologies and/or measures

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After completion of the 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 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 project activity.

The Project is a run-of-river hydropower project. The total install capacity of the project is 19.2MW (7.4MW+7.4MW+4.4MW). The construction of the project includes fixed weir, a sand trap, intake, headrace canal, headrace tunnel, forebay, penstock, powerhouse and a tailrace.

The project is located at downstream of the planned NN3 project, the NN3 project will be in operation at 1 Jan. 2020. After the completion of NN3 project, the water flow of the project will be decreased significantly. As estimated by the FSR designer, in the dry season (from Jan. to Jun.) the power generation will be reduced 52.7%, in the rain season (from Jul. to Dec.), the power operation will be reduced 16.3%. The estimated power generation before and after NN3 operation as follows (unit: MWh):

	Jan. to Jun.		Jul. to Dec.		Total
	Peak	Off-peak	Peak	Off-peak	
Before NN3 operation	35,770	26,827	40,131	27,272	130,000
After NN3 operation	24,450	5,118	35,452	20,980	86,000

The power generated will be delivered to EDL.

The parameters of the main equipment summarized in the below table:

Table A.1 Parameters of the main equipment

	Unit	Value	
Turbines:			
Type	-	Horizontal Francis Turbine	
Installed Capacity	MW	7.4	4.4
Number	-	2	1
Water head	m	117.85	117.85
Rotation Speed	rpm	750	1,000
Contractor	-	Voith Hydro Private Limited	
Generators:			
Type	-	Horizontal Synchronous Generator (Cylindrical Rotor Type)	
Installed Capacity	MW	7.4	4.4
Number	-	2	1
Voltage	kV	6.3	6.3
Frequency	HZ	50	50
Power Factor	-	0.85	0.85
Contractor	-	Voith Hydro Private Limited	

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)	Nam Pha Gnai Hydropower Co., Ltd. (Project owner)	No
Switzerland	Swiss Carbon Assets Limited	No

A.5. Public funding of project activity

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

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

B.1. Reference of methodology and standardized baseline

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Approved consolidated baseline and monitoring methodology ACM0002 (Version 16.0, EB 81): Grid-connected electricity generation from renewable sources.

This methodology draws upon the following tools:
Tool for the demonstration and assessment of additionality (Version 7.0.0, EB 70), and
Tool to calculate the emission factor for an electricity system (Version 4.0.0, EB 75)

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

B.2. Applicability of methodology and standardized baseline

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

Applicability	Applicable? Yes/No	Justification/Explanation
This methodology is applicable to grid-connected renewable energy power generation project activities that: (a) Install a Greenfield power plant; (b) Involve a capacity addition to (an) existing plant(s); (c) Involve a retrofit of (an) existing operating plant(s)/unit(s); (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or (e) Involve a replacement of (an) existing plant(s)/unit(s).	Yes	As a new hydropower project, the (a) Install a Greenfield power plant is applicable to the project.
The methodology is applicable under the following conditions: (a) The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit; (b) In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, solar, wave or tidal power capacity addition projects) the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity.	Yes	(a) The project type is hydropower plant without reservoir. (b) The Project is not capacity additions, retrofits, rehabilitations or replacements type, thus the applicability is not relevant to the project.

In case of hydro power plants, one of the following conditions shall apply: (a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or (b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density is greater than 4 W/m^2; or (c) The project activity results in new single or multiple reservoirs and the power density is greater than 4 W/m^2; or (d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs is lower than or equal to 4 W/m^2, all of the following conditions shall apply: (i) The power density calculated using the total installed capacity of the integrated project, is greater than 4 W/m^2; (ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity; (iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m^2 shall be: a. Lower than or equal to 15 MW; and b. Less than 10 per cent of the total installed capacity of integrated hydro power project.	Yes	There is no reservoir for the project, thus there is no power density of the project. The project matches with the above applicability criterion.
In the case of integrated hydro power projects, project proponent shall: (a) Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or (b) Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under CDM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum five years prior to implementation of CDM project activity.	Not relevant	The project is not an integrated hydro power project, the applicability is not relevant to the project.
The methodology is not applicable to: (a) Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site; (b) Biomass fired power plant(s)/unit(s).	Yes	As a Greenfield hydropower project, the applicability is applicable.

In the case of retrofits, rehabilitations, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, that is to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".	Not relevant	The project is not retrofits, rehabilitations, replacements, or capacity additions, the applicability is not relevant to the project.

"Tool to calculate the emission factor for an electricity system" (Version 4.0.0) was adopted to estimate the emission factor of the project. According to the "Tool to calculate the emission factor for an electricity system":
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, i.e. 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).

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. Therefore, the "Tool to calculate the emission factor for an electricity system" is applicable for this project.

B.3. Project boundary

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Spatial boundary

The power generated by the 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 project boundary.

According to ACM0002 (Version 16.0), 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.

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[1]. So, the electricity system does not have significant transmission constrain.

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

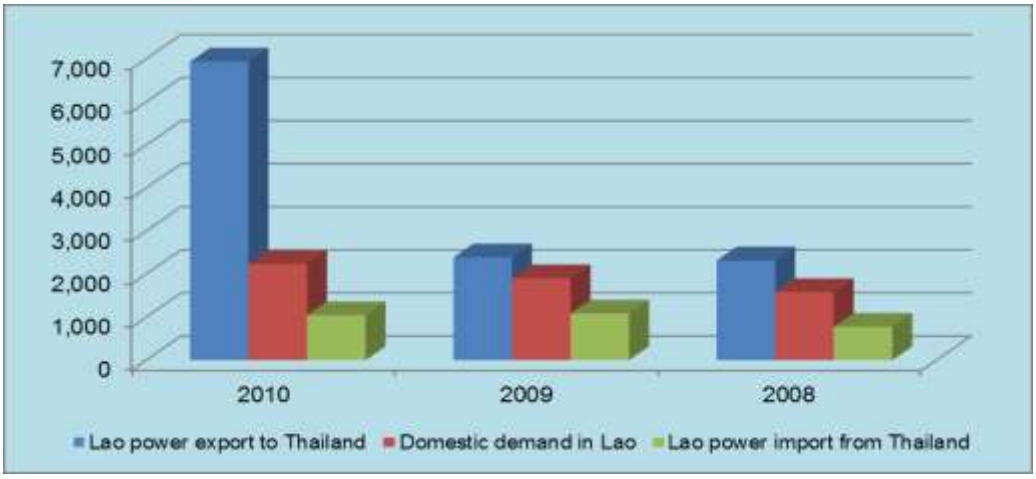

Figure B.1 Power exchange between Lao and Thailand (Unit: GWh)

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[5]. 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 project electricity system is a regional grid consisting of Thailand Power Grid and

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

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

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

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

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

the Lao Power Grid.

Emission sources and gases

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

Table B.2. GHG emissions in Project boundary

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project scenario	For 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	
	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

A flow diagram of the project boundary is presented in Figure B.2 below. The flow diagram physically delineates the project boundary, includes the flow of electricity and the project electricity system (the regional grid consisting of Thailand Power Grid and the Lao Power Grid), and the GHG emissions.

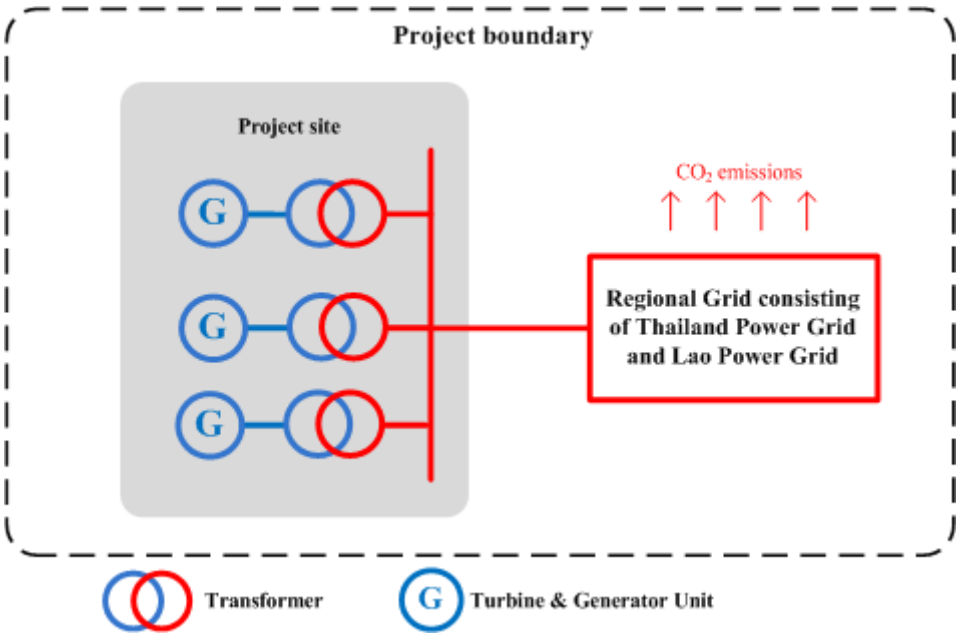

Figure B.2 Flow diagram of the project boundary

B.4. Establishment and description of baseline scenario

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According to ACM0002 (Version 16.0), if the project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is the following:

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

The 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 4.0).

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.

In the 10/10/2013, the prior consideration form was submitted to both the DNA and UNFCCC.

Currently, the project has not started yet, the prior consideration form was submitted before the project start, the 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. Basic parameters of the project

Milestone	Data
EIA finished	Aug, 2012
EIA Approval	2 Aug, 2012
FSR finished	Mar. 2013
FSR Approval	19 Apr, 2013
Invest Decision of the Project owner	11 Sep, 2013
Submitted the Prior CDM consideration to Lao DNA	10 Oct, 2013
The Prior CDM consideration to EB confirmed by UNFCCC secretariat	10 Oct, 2013
Power Purchase Agreement	26 Dec, 2013
Signed ERPA	08 Aug, 2014
PDD published for global stakeholder consultation	30 Sep, 2014
Project Construction Contract (Starting date)	**29 Oct, 2014**
Got Lao LoA	14 Jan, 2015
Got Switzerland LoA	21 Jul. 2015

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

Additionality

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

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

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

Alternative a): The 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 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 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 Pha Gnai 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*[6], 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 Pha Gnai 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 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 project activity are Alternatives a), d).

Step 2. Investment analysis

The purpose of this step is to determine whether the 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;

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

(Option III) Benchmark analysis;

Since the 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 project is supply electricity by the regional grid rather than newly invested projects. Therefore Option II is not appropriate. The project will use benchmark analysis method (Option III) based on the consideration that benchmark 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 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 project activity can be implemented by the project participant, the specific financial/economic situation of the company undertaking the project activity can be considered. The 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 project participants can demonstrate that the above Options are not applicable and their indicator is appropriately justified.

For this project, option a) was applied. The 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[7] at the recent 20 years before the starting date (Aug 13th 1994 ~ Aug 12th 2014) 2.78% 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[8];
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[9] 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] Website of the Federal Reserve Bank of St. Louis http://research.stlouisfed.org/fred2/series/DGS3MO?cid=47

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

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

7.0.0)". To reduce the short term uncertainty, the average risk premium of Lao PDR in the latest 5 years 12.68% was adopted (the risk premium of Lao PDR from 2006 to 2010 are 11.70, 10.10, 11.70, 15.30 and 14.60 respectively).

So, the 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 15.46% (post-tax).

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

1) Basic parameters for calculation of financial indicators

Based on the Feasibility Study Report (FSR) accomplished by the third party, 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	19.2	FSR
Static investment	10^6 USD	41.8	FSR
Annual net power supplied	GWh	130 (before year 2020)	FSR
		86 (after year 2020)	FSR
Electricity tariff	USD/KWh	0.06495	FSR
Operation period	year	25	FSR
Construction period	year	2	FSR
Profit Tax	%	15	FSR
Business Turnover Tax	%	5	FSR
Minimum Tax	%	0.25	FSR

The analysis shows that without the revenue of CERs, the IRR of the project will be 10.99%. Much lower than the benchmark 15.46%. 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 (including VAT)
- Power supplied to the grid

In case of the ±10% variation range of the four parameters, the fluctuations of the 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	12.75%	11.83%	10.99%	10.23%	9.52%
Annual O&M cost	11.19%	11.09%	10.99%	10.90%	10.80%
Electricity tariff	9.43%	10.22%	10.99%	11.75%	12.50%
Power supplied to the grid	9.43%	10.22%	10.99%	11.75%	12.50%

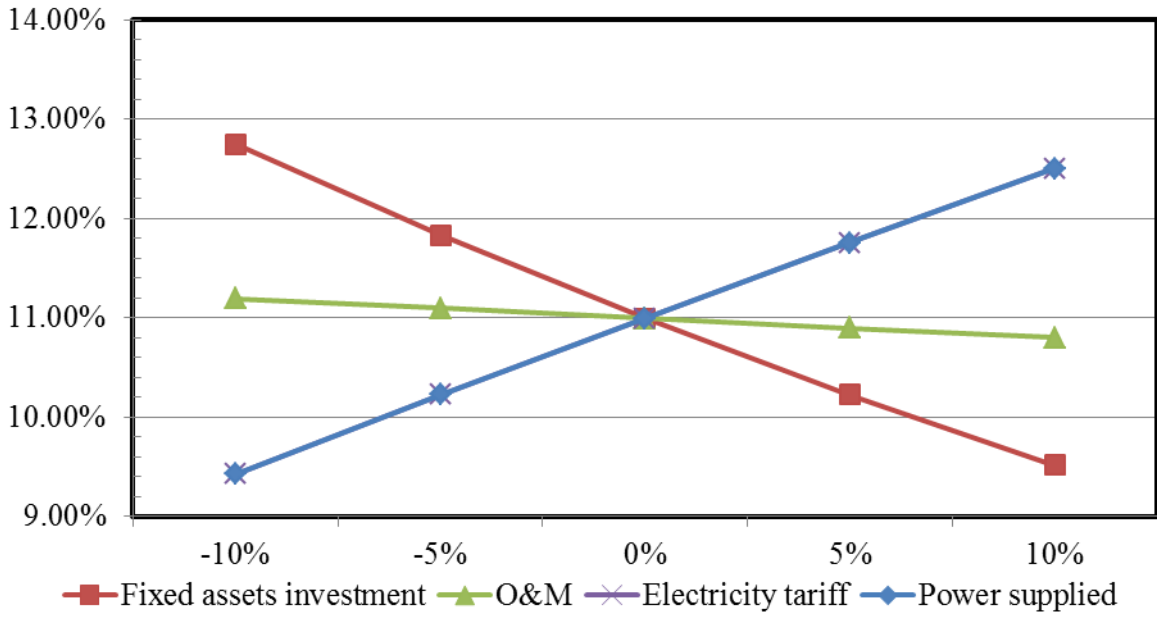

Figure B.3 Sensitive analysis

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 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 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.

The table below shows the critical point of the four parameters when the project IRR is equal to the benchmark.

Table B.6 Parameter changes when project IRR is equal to the benchmark

Change of Parameters	Fixed asset investment	O&M	Electricity tariff	Power supplied
Project IRR=Benchmark	-22.37%	-245.32%	31.18%	31.18%

The results show that when the project IRR is equal to the benchmark value, the fixed asset investment or O&M costs need to be decreased by 22.37%, and 245.32% respectively, or electricity tariff or power supplied amount need to be increased by 31.18% and 31.18% respectively. These are cases that are unlikely to occur.

- **Regarding to the fixed asset investment**

The case of a decrease in fixed asset investment by 22.37% is unlikely to occur. According to the signed main contracts, the actual fixed asset investment accounted for 100.48% of the total static investment estimated in the FSR, thus it is not impossible for the statistic investment to decrease by 22.37%.

- **Regarding to the O&M cost**

It can be seen that even the annual O&M cost decreased to 0, the project IRR is still below the benchmark.

- **Regarding to the electricity tariff**

As for the electricity tariff, if it increased by 31.18% the project IRR would be equal to benchmark. The electricity tariff (0.06495 USD/kWh) used at the time of investment decision is derived from FSR. The electricity tariff in Lao PDR has been determined mainly by negotiation with the grid company. According to '*Power Purchase Agreement*' signed with EdL, the actual electricity tariff is

0.06495 USD/kWh in the project's operation period (25 years), thus electricity tariff increased by 31.18% is unlikely to occur.

- **Regarding to the power supplied amount**

When the power supplied amount is increased by 31.18%, the project IRR can reach the benchmark. According to the FSR, the annual electricity was estimated and calculated by the chartered specialists based on a long series hydrology data. Therefore the annual electricity output will not be changed so much. Furthermore, as described in Section A.3, after the upstream NN3 project in operation, the waterflow will be influenced and the power supply will be decreased from 130GWh to 86 GWh, thus the power supplied increased by 31.18% is unlikely to occur. Even the NN3 project is not in operation, the 130GWh used for estimation, the IRR is 14.51% which is still lower than the benchmark (15.46%).

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

Step 3 Barrier analyses

This step is not adopted.

Step 4 Common practice analyses

Sub-step 4a. Analyze other activities similar to the project activity

As per "*Tool for the Demonstration and Assessment of Additionality"*, projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory frame-work, investment climate, access to technology, access to financing, etc. According to the "*Guidelines On Common Practice" (version 03.1),* common practice analysis is presented through the following steps.

Step 1: Calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity.

The installed capacity of Nam Pha Gnai Hydropower Project is 19.2MW, the projects with capacity ±50% of the project (9.6~28.8 MW) are considered as similar size.

Step 2: Identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:

(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;
(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of the proposed project activity, whichever is earlier for the project activity.

Considering the status of the project activity, the projects fulfil the following conditions are identified as the similar projects:

(a) The regulatory policies, investment environment and hydrology conditions are different by countries, therefore, Lao PDR where the project located is selected as the applicable area for common practice.
(b) According to the definition of the Measure in "*Guidelines On Common Practice" (version 03.1)*, there are four types of measures. As the project is a hydropower power project based on renewable energy, thus the project's measure belongs to **Measure (b)** "*Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies (example: energy efficiency improvements, power generation based on renewable energy).*" Thus, the projects apply measure (b) are selected as the similar projects.
(c) As a hydropower project, the energy source and feedstock is hydro, thus the projects using hydro selected as the similar projects.
(d) As a hydropower project, the output is electricity, thus the electricity plants are selected as the similar projects.
(e) As presented in Step 1, the Projects with installed capacity of 9.6~28.8MW are selected as the similar projects.
(f) As shown in Section B.5, The starting date of the project is 29 Oct, 2014, and the date to publish for global stakeholder consultation is 30 Sep, 2014, the earlier date is 30 Sep, 2014, thus the projects which started commercial operation before 30 Sep, 2014 are selected for further analysis.

In conclusion, the hydropower projects in Lao PDR with installed capacity of 9.6~28.8MW which start commercial operation before 30 Sep, 2014 are identified as the similar projects.

According to EDL Annual Report 2010 and Electric Power Plants in Laos[10], there are 1 project was observed.

Table B.7 Similar hydropower projects comparison

Project name	Capacity MW	Commissioning year	CDM application
Xe Namnoy 1	14.8	2013	Yes[11]

Step 3: Within the projects identified in Step 2, identify those that neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

As mentioned in the Table B.7, there are one project identified in Step 2. The identified Xe Namnoy 1 Hydropower project is a registered CDM project. According to the criteria provided by the "*Guidelines On Common Practice"*, the parameter N_{all} is 0.

Step 4: Within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

As mentioned in Step 3, there is no project identified, thus N_{diff}=0.

Step 5: Calculate factor $F=1- N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

As N_{diff}=0, there is no $F=1- N_{diff}/N_{all}$; Due to $N_{all}=N_{diff}=0$, $N_{all} - N_{diff} =0<3$.

Since $N_{all} - N_{diff} =0<3$, as per the "*Guidelines On Common Practice",* it can be concluded that the

[10] EDL Electric Power Plants in Laos Published in Feb, 2011.

[11] http://cdm.unfccc.int/Projects/DB/JACO1392860835.04/view

project is not a common practice and the project is additional.

In conclusion, all the steps above are satisfied, the proposed CDM project is not the baseline scenario, and the proposed project activity is additional.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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The Methodology ACM0002 (Version 16.0) is applied in the context of the project in the following four steps:

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

Calculate the project emissions

According to Methodology, the 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 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 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 project activity (W/m^2);

Cap_{PJ} Installed capacity of the hydro power plant after the implementation of the project activity (W);

Cap_{BL} Installed capacity of the hydro power plant before the implementation of the project activity (W). For new hydro power plants, this value is zero;

A_{PJ} Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2);

A_{BL} Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero;

According to the FSR, there is no reservoir for the project, thus $PE_{HP,y}$= 0. Then PE_y= 0 tCO_2.

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 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 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 project activity, then:

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

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 04.0).

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 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 project electricity system and connected electricity systems, therefore these delineations are applied. The 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 project electricity system (optional)

According to "*Tool to calculate the emission factor for an electricity system*" (Version 04.0.0), 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 04.0.0), 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.

$EF_{grid,OM\text{-}ave,y}$ 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.

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 project electricity system.

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

[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).

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 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 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 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:

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$$ (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 project leakage

No leakage emissions are considered.

Calculate the emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$ (Equation B.9)

Where:

ER_y	Emission reduction in year *y* (t CO_2e/y);
BE_y	Baseline emission in year *y* (t CO_2e/y);
PE_y	Project emission in year *y* (t CO_2e/y).

B.6.2. Data and parameters fixed ex ante

>>

Data / Parameter	$FC_{i,y}$
Unit	mass or volume unit of the fuel *i*
Description	Amount of fossil fuel type *i* consumed in the 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	Baseline Emission Calculation
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	Baseline Emission Calculation
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	Baseline Emission Calculation
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	130
Choice of data or Measurement methods and procedures	Data used are from Thailand DNA, TGO.
Purpose of data	Baseline Emission Calculation
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	Baseline Emission Calculation
Additional comment	-

Data / Parameter	A_{BL}
Unit	m^2
Description	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full

Source of data	Project site
Value(s) applied	0
Choice of data or Measurement methods and procedures	For new reservoirs, this value is zero.
Purpose of data	Project Emission Calculation
Additional comment	-

Data / Parameter	CAP_{BL}
Unit	MW
Description	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data	Project site
Value(s) applied	0
Choice of data or Measurement methods and procedures	For new hydro power plants, this value is zero
Purpose of data	Project Emission Calculation
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

Project emission

PE_y=0 tCO_2e

Baseline emission

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

Before 2020: $BE_y=EG_{PJ,y}\times EF_{grid,CM,y}=EG_{facility,y}\times EF_{grid,CM,y}$ = 130,000 ×0.55950=72,735 tCO_2e

After 2020: $BE_y=EG_{PJ,y}\times EF_{grid,CM,y}=EG_{facility,y}\times EF_{grid,CM,y}$ = 86,000 ×0.55950=48,117 tCO_2e

Project leakage

No leakage emissions are considered.

Emission reductions

Before 2020: $ER_y=BE_y-PE_y$ = 72,735 – 0 = 72,735 tCO_2e

After 2020: $ER_y=BE_y-PE_y$ = 48,117 – 0 = 48,117 tCO_2e

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

>>

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
01/01/2016~31/12/2016	72,735	0	0	72,735
01/01/2017~31/12/2017	72,735	0	0	72,735
01/01/2018~31/12/2018	72,735	0	0	72,735
01/01/2019~31/12/2019	72,735	0	0	72,735

01/01/2020~31/12/2020	48,117	0	0	48,117
01/01/2021~31/12/2021	48,117	0	0	48,117
01/01/2022~31/12/2022	48,117	0	0	48,117
Total	435,291	0	0	435,291
Total number of crediting years	7			
Annual average over the crediting period	62,184	0	0	62,184

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

>>

Data / Parameter	$EG_{facility,y}$
Unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y
Source of data	Calculated value
Value(s) applied	$EG_{facility,y} = EG_{output,y} - EG_{input,y}$
Measurement methods and procedures	Calculated
Monitoring frequency	Continuously
QA/QC procedures	Please refer to $EG_{output,y}$ and $EG_{input,y}$
Purpose of data	Baseline Emission Calculation
Additional comment	-

Data / Parameter	$EG_{output,y}$
Unit	MWh
Description	Electricity supplied by the project to the grid in year y
Source of data	Measured by meters
Value(s) applied	Before year 2020:130,000 After year 2020: 86,000
Measurement methods and procedures	Continuous measurement and monthly recording, Refer to Section B.7.3 for details.
Monitoring frequency	Continuously
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	Baseline Emission Calculation
Additional comment	-

Data / Parameter	$EG_{input,y}$
Unit	MWh
Description	The electricity used by the project and input from the grid in year y
Source of data	Measured by meters
Value(s) applied	0 MWh for ex-ante calculation

Measurement methods and procedures	Continuous measurement and monthly recording. Refer to Section B.7.3 for details.
Monitoring frequency	Continuously
QA/QC procedures	According to the recommendation by the manufacturer or the regulations by 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	Baseline Emission Calculation
Additional comment	-

Data / Parameter	Cap_{PJ}
Unit	W
Description	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data	Project site
Value(s) applied	19,200,000
Measurement methods and procedures	-
Monitoring frequency	Once at the beginning of each crediting period
QA/QC procedures	-
Purpose of data	Project Emission Calculation
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 project within the crediting period is complete, consistent, clear and accurate. The plan will be implemented by the project owner with the support of the grid corporation.

1. Monitoring organization

The monitoring process will be carried out and responsibility by the 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:

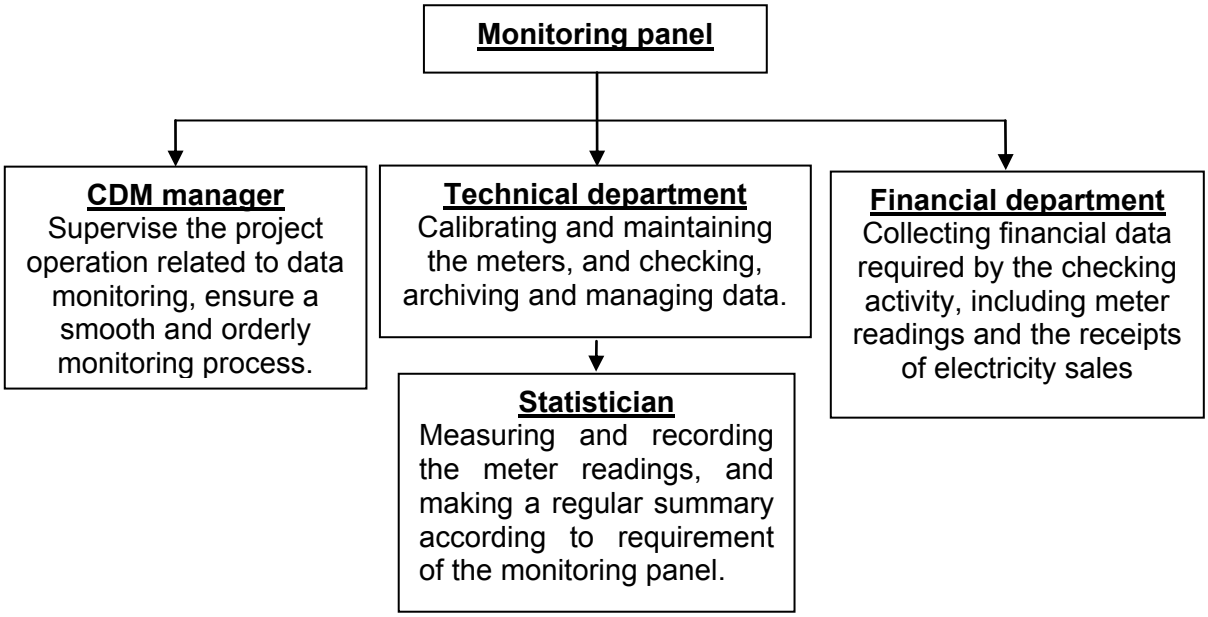

Figure B.4 Organization structure of the monitoring activity

2. Monitoring apparatus and installation:

The meter(s) will be installed in accordance with relevant national or international standard. Before the operation of the project, the meter(s) will be clarified and examined by the project owner and the power grid company according to the regulation.

The M1 and M2 are bidirectional meters. Meter M1 will be the main meter, installed at the grid access points, to monitoring both the input and output electricity. Meter M2 will be the backup meter for M1. The accuracy of M1 and M2 is 0.5. Therefore, the reading from M1 upload will be recorded for the $EG_{output,y}$, and the M1 download will be recorded for $EG_{input,y}$.

The power generated will be delivered to the local power grid through a 22kV transmission line.

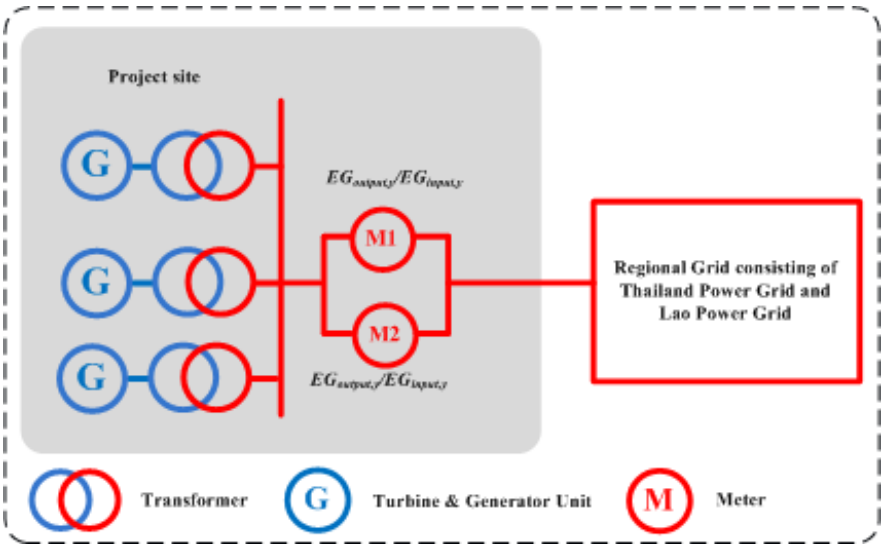

Figure B.5 Monitoring points of the project

3. Data collection:

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

a) During the crediting period, both the grid company and the project owner will record the values displayed by the main meter.

b) Simultaneously to step a), the project owner will 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 the record document confirmed by EdL.
e) The project owner and the grid company will record both output and input power readings. These data will be used to calculate the amount of net electricity delivered to the grid.
f) The project owner will be responsible of providing copies of record document confirmed by EdL to the DOE for verification.

If the reading of 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:

g) Read the data of the backup meters.
h) If the backup meter's data is not accurate enough to be accepted, or the practice is not standardized, the project owner and grid company 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.
i) If the 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.

4. Calibration

Calibration should be implemented according to relevant standards and rules accepted by the grid company EdL. The meter(s) will be tested before installation and calibrated at least once every twelve (12) months.

All the meters installed shall be tested by a qualified metering verification institution commissioned jointly by the 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 be operated in accordance with the specifications.

5. 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 project materials and monitoring results will be indexed. All paper-based information will be stored by the technical department of the 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.

6. 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 projects participants. Once the final report is issued, it will be submitted to the DOE for verification.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>>
Date of completion of application of methodology and standardized baseline:
03/11/2015

Responsible persons/ entities:
Mr. Lu Yaodong

Beijing Karbon Energy Consulting Co., Ltd.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>>
29/10/2014 (Signed the Project Construction 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

>>
First period of renewable crediting period

C.2.2. Start date of crediting period

>>
01/01/2016

C.2.3. Length of crediting period

>>
7 years of the first crediting period

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The Initial Environmental Examination with Environmental Management Plan for Nam Pha Gnai Hydropower project was compiled by qualified institute. According to this 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 EIA 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

>>
The Initial Environmental Examination for Nam Pha Gnai Hydropower project has been approved by qualified department. The impact by the project is insignificant.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>>
In order to develop the project as a Gold Standard CDM project, a Local Stakeholder Consultation Meeting held in September 2014 before the construction started.

Stakeholders were invited to attend the meeting through different means including:
- Personal face to face invitations to government officer
- E-mail correspondence
- Invitation letter posted on the village Bulletin Board

Local people were invited to the meeting via personal face to face invitations and posters. Local government officers were invited to the meeting via face to face invitations and invitation letter. In addition, NGOs were invited to the meeting via e-mails sent.

Finally, 50 stakeholders participated in the meeting. The meeting was opened by the introduction of the project developers and the representative from the project owner company. The objective of the meeting was based on the non-technical summary, Environmental Management Plan and draft Passport Report of the project. In addition, a presentation was provided for addressing the issues about project specifications. Also, how the project might have some environmental effects, how these issues will be mitigated by the investor and also climate change and how the project will help the fight against climate change were discussed.

During the invitation process and the stakeholder meeting, the evaluation forms were handed out and the stakeholder were asked for their comments and requests about the project. The questions of the stakeholders were responded during the consultation meeting and their requests were assessed.

E.2. Summary of comments received

>>
During the consultation meeting, stakeholders' comments were positive about the Project. Stakeholders had some comments about the project and asked for some contributions from the project owner. The main issues raised by the participants during the meeting were:
- Job opportunities
- Stable electricity supply
- Wastewater generation during construction
- Land occupy & Compensation
- Technology reliable

E.3. Report on consideration of comments received

>>

All comments from stakeholders were taken into account and promptly responded as given below.

- Job opportunities: Project Owner's representative mentioned that all the construction works would be open for local construction company, and would request the company to recruit locally.
- Stable electricity supply: Some stakeholders expected the project owner could provide stable electricity to nearby village, the Project Owner's representative mentioned that it is not allowed to supply electricity directly from the plant to end user, but the project owner would keep the power line(s) for construction even after the project comes into operation, thus the surrounding village can use those power line(s) to connect to the grid.
- Wastewater generation during construction: Project Owner's representative mentioned that water is very important to the local residents, migration measures would be taken to avoid impacts on water quality, such as introduce sanitation facility to treat the human waste, collect dirty water from disturbed land and treat before release to the river.
- Land occupy& Compensation: Project Owner's representative confirmed that none village would be directly affected by the intake weir, access road and powerhouse construction, due to the project area is unpopulated in the traditional sense with half a day walk through a bery rough terrain from the nearest village (Ban Nam Pha Noi).
- Technology reliable: Project Owner's representative mentioned that mature technology and equipment from reputable manufacturer will be chosen. And the employees will be well trained.

SECTION F. Approval and authorization

>>

The Letter of approval from the Parties have been obtained already.

- - - - -

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	Nam Pha Gnai Hydropower Co., Ltd.
Street/P.O. Box	Souphanouvong Road, Nakham, Sykhothabong
Building	252/1
City	Vientiane Capital
State/Region	
Postcode	
Country	Lao PDR
Telephone	+856-21-217164
Fax	+856-21-240949
E-mail	sayasithss@gmail.com
Website	
Contact person	Sayasith Sanakeo
Title	General Manager
Salutation	Mr.
Last name	Sanakeo
Middle name	
First name	Sayasith
Department	
Mobile	
Direct fax	+856-21-240949
Direct tel.	+856-21-217164
Personal e-mail	sayasithss@gmail.com

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	Swiss Carbon Assets Limited
Street/P.O. Box	Technoparkstrasse 1
Building	-
City	Zürich
State/Region	-
Postcode	8005
Country	Switzerland
Telephone	+41 43 501 35 50
Fax	+41 43 501 35 99
E-mail	registration@southpolecarbon.com
Website	-
Contact person	Renat Heuberger
Title	-
Salutation	Mr.
Last name	Heuberger
Middle name	-
First name	Renat
Department	-
Mobile	-
Direct fax	+41 43 501 35 99
Direct tel.	+41 43 501 35 50
Personal e-mail	

Appendix 2. Affirmation regarding public funding

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

Appendix 3. Applicability of methodology and standardized baseline

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

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

Appendix 5. Further background information on monitoring plan

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
	$FC_{i,y}$		$EF_{CO2,m,i,y}$	$NCV_{i,y}$	$FC_{i,y}$ x $EF_{CO2,m,i,y}$ x $NCV_{i,y}$/1000000
	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 6. Summary of post registration changes

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Document information

Version	*Date*	*Description*
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 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.

Version	Date	Description

Decision Class: Regulatory
Document Type: Form
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Keywords: project activities, project design document