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 project activity	Nam Ngao Hydropower Project
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	2.0
Completion date of the PDD	18/11/2017
Project participants	Heuangpaseuth Hydropower Co., Ltd. Swiss Carbon Assets Limited
Host Party	Lao PDR
Applied methodologies and standardized baselines	AMS-I.D. Grid connected renewable electricity generation (Version 18.0, EB 81)
Sectoral scopes linked to the applied methodologies	Sectoral Scope 1: Energy Industries.
Estimated amount of annual average GHG emission reductions	45,375 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

Nam Ngao Hydropower Project (hereafter referred to as the “the project”) is located about 15km away from Houay Xay, the capital city of Bokeo Province, Lao PDR., and developed by Heuangpaseuth Hydropower Co., Ltd..

The project is a run-of-the-river hydropower station which includes fixed weir, a sand trap, intake, headrace canal, headrace tunnel, forebay, penstock, powerhouse and a tailrace. The installed capacity is 15MW (2×7.5MW), with annually 81.1 GWh power supplied to the power grid. The project’s installed capacity is 15MW which is regarded as small-scaled project type (Type I) in accordance with the project standard. Furthermore, the project is not a CFA or debunded project.

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. And the project boundary includes the project and regional power grid consisting of Thailand Power Grid and the Lao 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 45,375 tCO_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

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The Project site is located about 15km away from Houay Xay, the capital city of Bokeo Province, Lao PDR. The approximate coordinates of the project site (Weir) is: 20.3835°N, 100.3942°E.

Figure A.1 Show the location of the project:

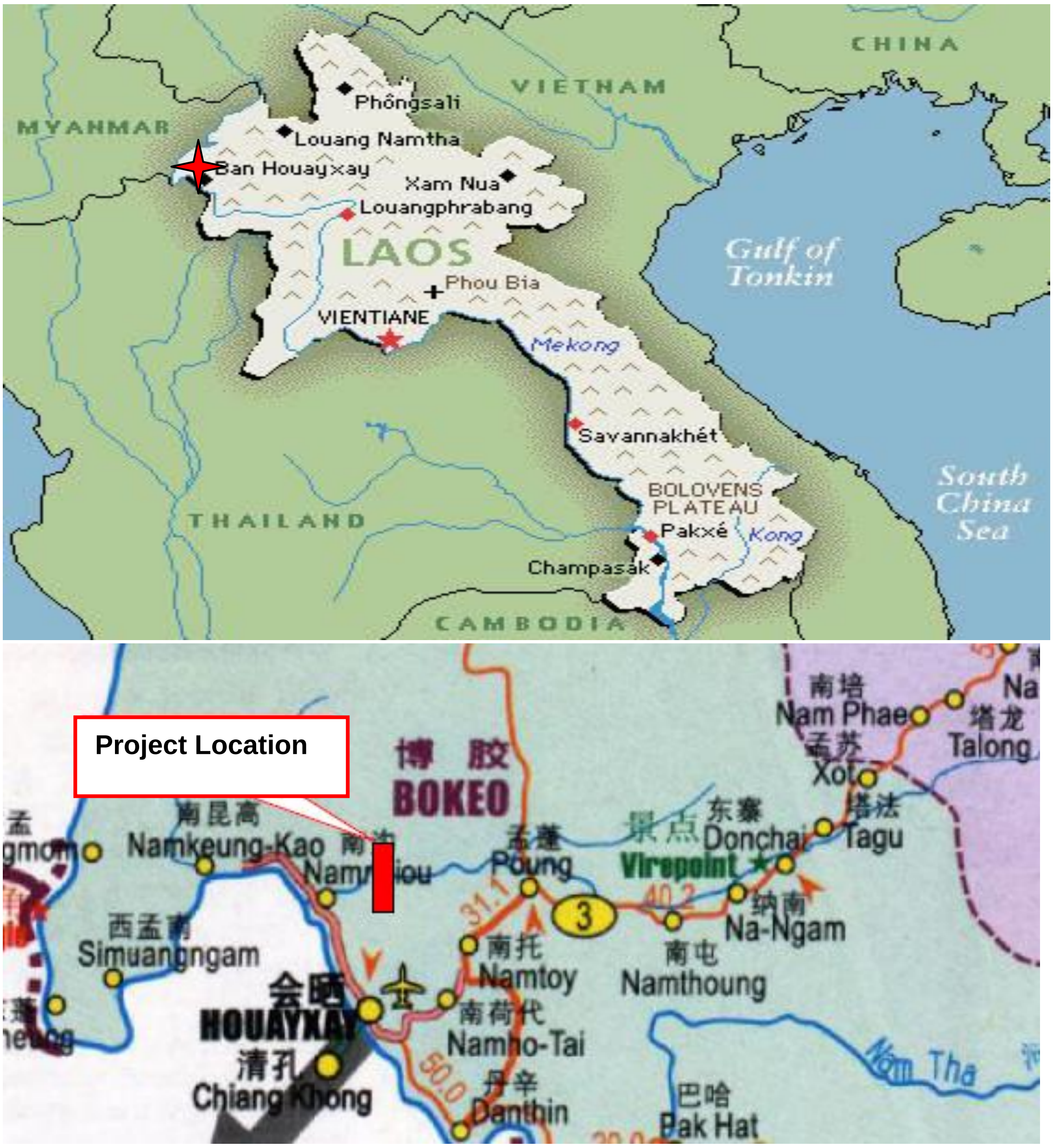

Figure A.1 Location of the project

A.3. Technologies/measures

>>

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 15MW (2×7.5MW). The construction of the project includes fixed weir, a sand trap, intake, headrace canal, headrace tunnel, forebay, penstock, powerhouse and a tailrace. The main parameters of the equipment as follows:

Table A.1 main parameters of the equipment[1]

Parameters		Unit	Value
Turbine	Number	-	2
	Model	-	HL282-LJ-215
	Rated output	MW	7.8
	Rated speed	r/min	214.3
	Runner diameter	m	2.15
	Rated head	m	32.5
	Rated discharge	m^3/s	35.72
	Average Lifetime	Years	25
Generator	Number	-	2
	Model	-	SF7.5-28/3800
	Rated capacity	MW	7.5
	Voltage	kV	6.3
	Power factor	-	0.8
	Rated speed	r/min	214.3
	Rated frequency	Hz	50
	Average Lifetime	Years	25

There is no technology/measure or know-how involved transferred to the host Party.

The annual net electricity supply for the project will be 81.1GWh. The meters will be installed in accordance with relevant national or international standard. Before the operation of the project, the metering equipments will be clarified and examined by the project owner and the power grid company according to the above regulation. The power generated will be delivered to EDL through transmission lines.

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)
Lao PDR (host)	Heuangpaseuth Hydropower Co., Ltd. (Project owner)	No
Switzerland	Swiss Carbon Assets Limited	No

A.5. Public funding of project activity

>>
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.

A.6. History of project activity

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[1] Due to the Equipment's Parameter Technical Protocol was not obtained, the parameters were derived from Project's FSR.

It is confirmed that:

(a) The project is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA);

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

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

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

A.7. Debundling

>>

According to “Assessment of Debundling for Small-Scale Project Activities” (Version 4.0, EB 83, Annex 13), 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

>>
Baseline methodology:
I.D. Grid connected renewable electricity generation (Version 18.0, EB 81).

This methodology draws upon the following tools:

- Tool for the demonstration and assessment of additionality (Version 7.0.0, EB 70),
- Demonstration of additionality of small-scale project activities (Version 11.0, EB 94), and
- Tool to calculate the emission factor for an electricity system (Version 5.0, EB 87)

And the Approved consolidated baseline and monitoring methodology ACM0002 (Version 17.0, EB 89): Grid-connected electricity generation from renewable sources.

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

B.2. Applicability of methodologies and standardized baselines

>>
The Project is a grid connected renewable electricity generation project which meets all the applicability criteria stated in methodology ASM I.D (Version 18.0):

- The project makes use of renewable water resources to generate electricity to the regional grid consisting of Thailand Power Grid and the Lao Power Grid;
- The project will install new power plant at the site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant);
- Power density of the project is greater than 4 W/m^2;
- The total installed capacity of the project is 15 MW, it satisfies the requirement that the capacity of the project should be at most 15 MW for a small-scale CDM project.
- The other criteria stated in the AMS I.D are not applicable to the 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 5.0) 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, sources and greenhouse gases (GHGs)

>>
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 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.

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 "*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[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

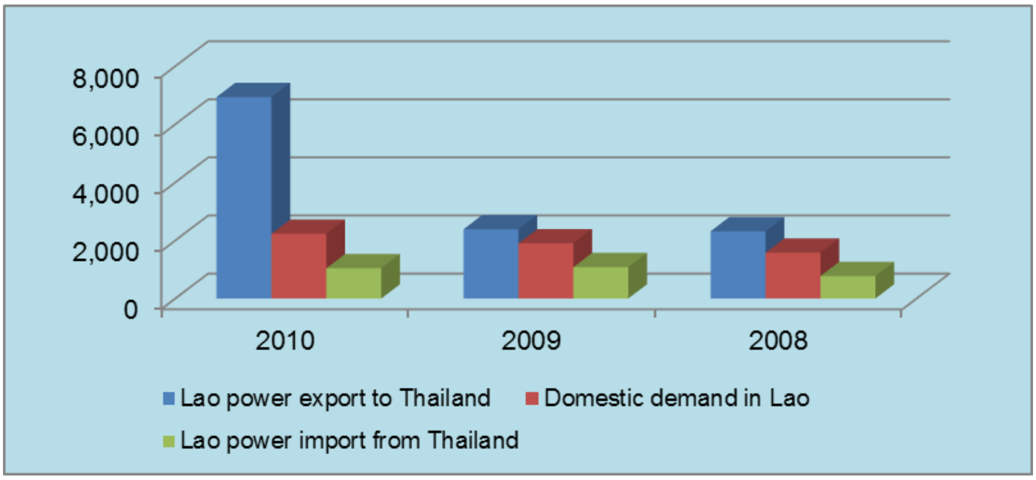

Figure B.1 Power exchange between Lao and Thailand (Unit: GWh)

[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.

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 MWh 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 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 project boundary are shown in the table below.

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 project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	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	Not applicable to hydro power Project
		N_2O	No	Not applicable to hydro power Project
	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	Not applicable to hydro power Project
		N_2O	No	Not applicable to hydro power Project
	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.

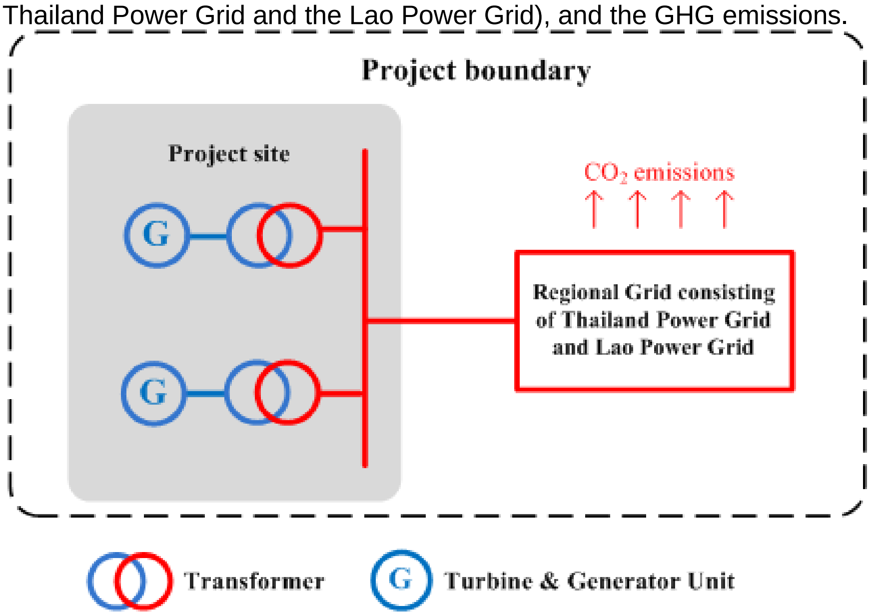

Figure B.2 Flow diagram of the project boundary

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

B.4. Establishment and description of baseline scenario

>>
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.

B.5. Demonstration of additionality

>>
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 06/01/2015, the prior consideration form was submitted to both the DNA and UNFCCC within 6 months of the start date.

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
FSR finished	Aug. 2013
FSR Approval	2/9/2013
EIA finished	Jan, 2014
EIA Approval	16/1/2014
ERPA with buyer	30/6/2014
Submitted the Prior CDM consideration to Lao DNA	6/1/2015
The Prior CDM consideration to EB confirmed by UNFCCC secretariat	6/1/2015
PDD Global Stakeholder Consulting (GSC)	14/4/2015~13/5/2015
Construction Contract (Start Date)	24/5/2015
Switzerland LoA	22/1/2016
Lao PDR LoA	27/9/2016

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

<u>Assessment and demonstration of additionality</u>

According to the “Demonstration of additionality of small-scale project activities” (Version 10.0), the positive list of technologies and project activity types that are defined as automatically additional for project sizes up to and including the small-scale CDM thresholds (e.g. installed capacity up to 15 MW). The positive list comprises of:

(a) The following grid-connected and off-grid renewable electricity generation technologies:
- (i) Solar technologies (photovoltaic and solar thermal electricity generation);
- (ii) Off-shore wind technologies;
- (iii) Marine technologies (wave, tidal);
- (iv) Building-integrated wind turbines or household rooftop wind turbines of a size up to 100 kW;

(b) The following off-grid electricity generation technologies where the individual units do not exceed the thresholds indicated in parentheses with the aggregate project installed capacity not exceeding the 15 MW threshold:
- (i) Micro/pico-hydro (with power plant size up to 100 kW);
- (ii) Micro/pico-wind turbine (up to 100 kW);
- (iii) PV-wind hybrid (up to 100 kW);
- (iv) Geothermal (up to 200 kW);

(v) Biomass gasification/biogas (up to 100 kW);

(c) Project activities solely composed of isolated units where the users of the technology/measure are households or communities or Small and Medium Enterprises (SMEs) and where the size of each unit is no larger than 5% of the small-scale CDM thresholds;

(d) Rural electrification project activities using renewable energy sources in countries with rural electrification rates less than 20%; the most recent available data on the electrification rates shall be used to demonstrate compliance with the 20 per cent threshold. In no case shall data be used if older than three years from the date of commencement of validation of the project activity.

Due to the technology and project activity type is not listed in the positive list, additionality analysis cannot be omitted. The "Demonstration of additionality of small-scale project activities" (Version 11.0) and "Attachment A to Appendix B of the Simplified Modalities and Procedures for Small-scale CDM Project Activities", 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. Due to the "Demonstration of additionality of small-scale project activities" (Version 11.0) does not provide assessment method of investment barrier, the "*Tool for the demonstration and assessment of additionality*" (Version 7.0.0) is used, 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 Ngao 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 Ngao 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;
(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;*

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

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[8] at the recent 20 years before the starting date (Mar 14th 1995 ~ Mar 13rd 2015) 2.63% 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 to 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 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 15.31% (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	15	FSR
Static investment	10^6 USD	38.92	FSR
Annual net power supplied	GWh	81.1	FSR
Electricity tariff	USD/KWh	0.065	FSR
Operation period	year	25	FSR
Construction period	year	3	FSR
Profit Tax	%	15	FSR
Business Turnover Tax	%	5	FSR
Minimum Tax	%	0.25	FSR

[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

The analysis shows that without the revenue of CERs, the IRR of the project will be 8.27%. Much lower than the benchmark 15.31%. 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	9.61%	8.92%	8.27%	7.68%	7.13%
Annual O&M cost	8.46%	8.37%	8.27%	8.18%	8.09%
Electricity tariff	6.98%	7.64%	8.27%	8.90%	9.50%
Power supplied to the grid	6.98%	7.64%	8.27%	8.90%	9.50%

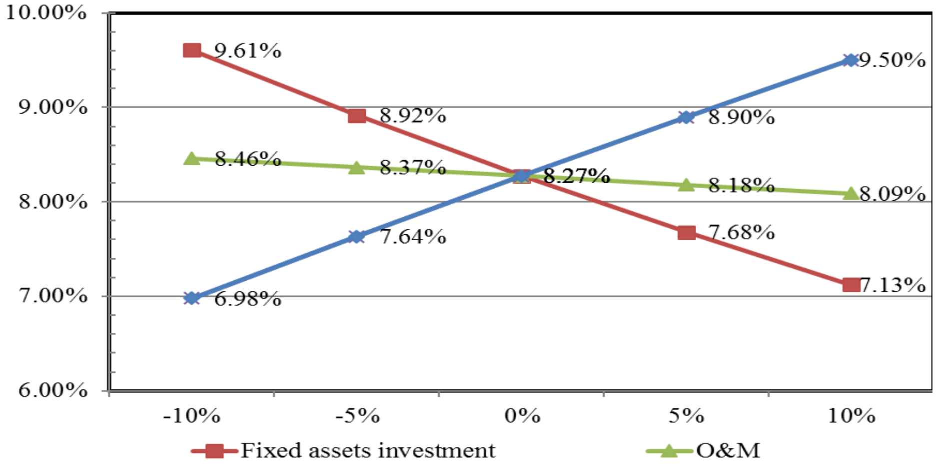

Figure B.3 Sensitive analysis

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.

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.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>>
The Methodology AMS-I.D. 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:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$$ (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:

$$PE_{HP,y} = \frac{EF_{Res} \cdot TEG_y}{1000}$$ (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

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

The PD of the project activity is calculated as follows:

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

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$$ (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:

$$EG_{PJ,y} = EG_{facility,y}$$ (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 05.0).

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[11] 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[12].

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 05.0), 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.

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

[12] 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).

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 05.0), 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.

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:

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

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

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 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 (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	$FC_{i,\ y}$
Data 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	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$NCV_{i,y}$
Data 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	$EF_{CO2, i, y}$
Data 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
Data 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	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$EG_{import,y}$
Data 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_y=0 tCO_2e

Baseline emission

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

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

The baseline emission of the project:

$BE_y = EG_{PJ,y} \times EF_{grid,CM,y} = EG_{facility,y} \times EF_{grid,CM,y}$ = 81,100 ×0.5595=45,375 tCO_2e

Project leakage

No leakage emissions are considered.

Emission reductions

$ER_y = BE_y - PE_y$ = 45,375 – 0 = 45,375 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)
01/01/2018~31/12/2018	45,375	0	0	45,375
01/01/2019~31/12/2019	45,375	0	0	45,375
01/01/2020~31/12/2020	45,375	0	0	45,375
01/01/2021~31/12/2021	45,375	0	0	45,375
01/01/2022~31/12/2022	45,375	0	0	45,375
01/01/2023~31/12/2023	45,375	0	0	45,375
01/01/2024~31/12/2024	45,375	0	0	45,375
Total	**317,625**	**0**	**0**	**317,625**
Total number of crediting years	**7**			
Annual average over the crediting period	**45,375**	**0**	**0**	**45,375**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

>>

Data/Parameter	$\boldsymbol{EG_{facility,y}}$
Data unit	MWh
Description	Quantity of net electricity generation supplied by the project plant/unit to the grid in year y
Source of data	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 $\boldsymbol{EG_{output,y}}$ and $\boldsymbol{EG_{input,y}}$
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$\boldsymbol{EG_{output,y}}$
Data unit	MWh
Description	Electricity supplied by the project to the grid in year y
Source of data	Measured by meters
Value(s) applied	81,100
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	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$\boldsymbol{EG_{input,y}}$
Data 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	Calculation of baseline emissions
Additional comment	-

B.7.2. Sampling plan

>>
Not applicable.

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:

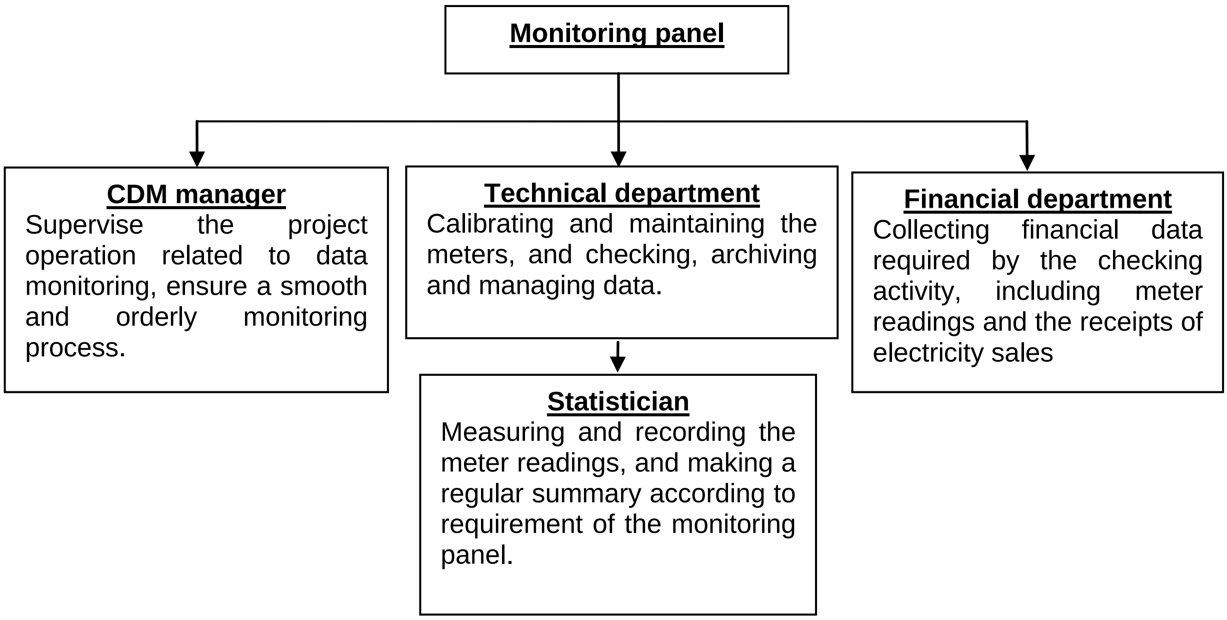

Figure B.4 Organization structure of the monitoring activity

2. Monitoring apparatus and installation:

The meters will be installed in accordance with relevant national or international standard. Before the operation of the project, the metering equipments will be clarified and examined by the project owner and the power grid company according to the above regulation. The power generated will be delivered to EDL through transmission lines.

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 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 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 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:

g) Read the data of the backup meters.
h) If the backup meter’s data is not so accurate as to be accepted, or the practice is not standardized, the 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.

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 of Meters should be implemented according to relevant standards 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 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 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.

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.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
24/5/2015 (Construction Contract)

C.2. Expected operational lifetime of project activity

>>
25 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable crediting period

C.3.2. Start date of crediting period

>>
01/01/2018 or registration date, which is later

C.3.3. Duration 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 Ngao 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

>>
Not applicable.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

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According to the Social Impact Assessment compiled by Laos National Consulting Company, the stakeholders of the project comprise five main groups:

- People residing in the study area who may be affected directly and indirectly by the project
- Government officials at the district, government and national level
- The broader interested community
- NGOs operating in the Lao PDR
- International NGOs, international organizations and other interest groups, including the local, regional and national media.

Widely public consultations were carried out to reduce negative impacts, enhance positive community effects and make sure all the stakeholders involve in the decision-making and implement of the project. Series of Public Consultation workshop and information discloses. There have been officially consultation meeting at provincial level, district level as well as villages level during the field survey and Dialogue has been established with interested groups and stakeholders who are directly or indirectly involved in the Nam Ngao Hydropower Project and who have expressed a wish to participate in the project's public consultation program.

After the above mentioned activities, a CDM stakeholder meeting was held by the project owner, made a further investigation, make sure the local and indigenous communities participated in the decision-making process.

To ensure that locals were consulted in an open and transparent way, a survey was conducted via questionnaire distributed and collected by the project owner. The stakeholder meeting was held on 20/03/2015 and 23/03/2015 which for government officer and local residents respectively. 25 questionnaires were distributed and 24 questionnaires were returned.

The profile of the participants of survey is as follows:

Table E.1. Basic information of the survey participants

Item	Category	Number	Percentage
Age	Below 30	4	16.7%
	30~40	7	29.2%
	40~50	5	20.8%
	Above 50	8	33.3%
Gender	Male	19	79.2%
	Female	5	20.8%
Education	Elementary school	4	16.7%
	Junior high school	6	25.0%
	Senior high school	6	25.0%
	College and above	8	33.3%

A questionnaire was designed according to the Annex AC "Sustainable Development Indicator Questions" and "Gold Standard Rules and Toolkit", which covers different sustainable development matrix. Based on the feedback for the questionnaire, the Stakeholders' comments on social and environmental impacts as well as sustainable development were summarized.

Furthermore, to collect opinions from the participants, the stakeholders provided their comments freely without limited to the questionnaire in the meeting. The contents and results of this questionnaire survey were as follows:

1) Do you agree with the construction of the project;
2) What is the influence on local economic development for the project implement;
3) What is the influence on local residents' livelihood for the project implement;
4) Will the project improve the local employment;
5) What are the influences on the local environment you concern about;
6) In general, what's your opinion on the project environment effects.

E.2. Summary of comments received

>>

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 83.3% of the respondents consider the implement of the project have positive influence on local economic development, and 16.7% 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, 12.6% 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, 41.6% 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 other comments received from the stakeholders are summary as follows:

1) Does the project provide job opportunities to nearby village?
2) Some stakeholders expected the project owner could provide stable electricity to nearby village.
3) Is there Land occupied by the project?
4) Is the technology used in the project reliably?
5) Does the project's implementation affect the irrigation?

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) Job opportunities: All the construction works would be open for local construction company, and would request the company to recruit locally.
2) Stable electricity to nearby village: 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 lines to connect to the grid.

3) Land occupy: No village would be directly affected by the intake weir, access road and powerhouse construction, due to the project site is far away from villages.
4) Technology reliable: The reputable manufacturer will be chosen to provide mature technology and equipment.
5) Irrigation: There's no reservoir for the project to regulate the run off of the river, thus will not affect the water for irrigation. Actually project is far away from nearby village and there is no farmland nearby.

SECTION F. Approval and authorization

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Both the LoA of the Lao PDR and Switzerland were obtained. The LoA of each project participant is authorized by one Party in a authorization letter.

Appendix 1. Contact information of project participants

Organization name	Heuangpaseuth Hydropower Co., Ltd.
Country	Lao PDR
Address	Bannawannoi, Xay District, Udomxay Province, Lao PDR
Telephone	856-20-2312 8898
Fax	-
E-mail	-
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Contact person	Houmphan RATTANA

Organization name	Swiss Carbon Assets Limited
Country	Switzerland
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E-mail	registration@southpolecarbon.com
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 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

Year	Fuel Type	Fuel Consumption		Fuel Specific EF	Net Calorific Value	GHG emission
		$FC_{i,y}$		$EF_{CO2,m,i,y}$	$NCV_{i,y}$	$FC_{i,y} \times EF_{CO2,m,i,y} \times NCV_{i,y}/10^6$
		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

Not applicable.

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