CLEAN DEVELOPMENT MECHANISM

PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
VERSION 03 - IN EFFECT AS OF: 28 JULY 2006

CONTENTS

SECTION A. General description of project activity

A.1 Title of the project activity:

Nam Ngum 5 Hydropower Project

Version number of the document: 03

Date of completion: 26/11/2012

A.2. Description of the project activity:

Nam Ngum 5 Hydropower Project (hereafter referred to as "the proposed project") is located on Nam Ting River in Luangprabang Province and Xiangkhouang Province in Lao People's Democratic Republic (Lao PDR). The proposed project is constructed and operated by Nam Ngum 5 Power Company Limited.

The proposed project is a newly-built hydropower project. The total installed capacity of the proposed project is 120MW, involving the installation of two sets of 60MW hydro turbine and generator unit. The electricity generated by the proposed project will be supplied to the regional grid consisting of Lao Power Grid (LPG) and Thailand Power Grid (TPG) (hereafter referred to as "LPG&TPG"). The annual electricity supplied to the grid is expected to be 501,930MWh.

As identified in section B.4, in the absence of the proposed project, the most viable baseline scenario is "the same amount power provided by LPG&TPG". The proposed project will substitute a part of the electricity of LPG&TPG, resulting in reducing the CO_2 emission of LPG&TPG. The annual emission reductions of the proposed project are estimated to be 248,501tCO_2e.

The proposed project will achieve electricity generation by utilizing renewable water resources. It can promote local sustainable development from the following aspects:

1) The proposed project will add great benefit to the national economy and environmental sustainability while reducing CO_2 emissions;
2) The construction and operation of the proposed project will increase government revenue through tax, and stimulate the economic development of local area;
3) The proposed project will replace firewood consumption and save cutting down of trees contributing to environmental sustainability;
4) The construction and operation of the proposed project will create more job opportunities for local people. Rural labors could be arranged for on-site construction during the construction period, and some long-term job opportunities could be offered during the operation period.

A.3. Project participants:

Name of Party involved (*)((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Lao People's Democratic Republic (host) Kingdom of Thailand (host)	Nam Ngum 5 Power Company Limited	No
Netherlands	CF Carbon Fund II Limited	No

In its 28th meeting in December 2006, the CDM Executive Board clarified that the word "regional", in the context of "regional electricity system" used in ACM0002, can also be interpreted as extending across several countries. The EB further clarified that trans-national electricity systems are eligible under ACM0002 and the DNAs of countries in these regions, across which the electric system spans, shall be considered as host Parties.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Lao People's Democratic Republic

A.4.1.2. Region/State/Province etc.:

Luangprabang Province and Xiangkhouang Province

A.4.1.3. City/Town/Community etc:

Dam: Ban Chim/Phukhoun District; Powerhouse: Phoukout District

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The proposed project is located on Nam Ting River in Luangprabang Province and Xiangkhouang Province in Lao PDR. The geographical coordinates of the dam are east longitude of 102°27'9.13586" and north latitude of 19°21'23.80023". The geographical coordinates of the powerhouse are east longitude of 102°42'44.00212" and north latitude of 19°21'35.83757".The detailed project location is shown in Figure 1.

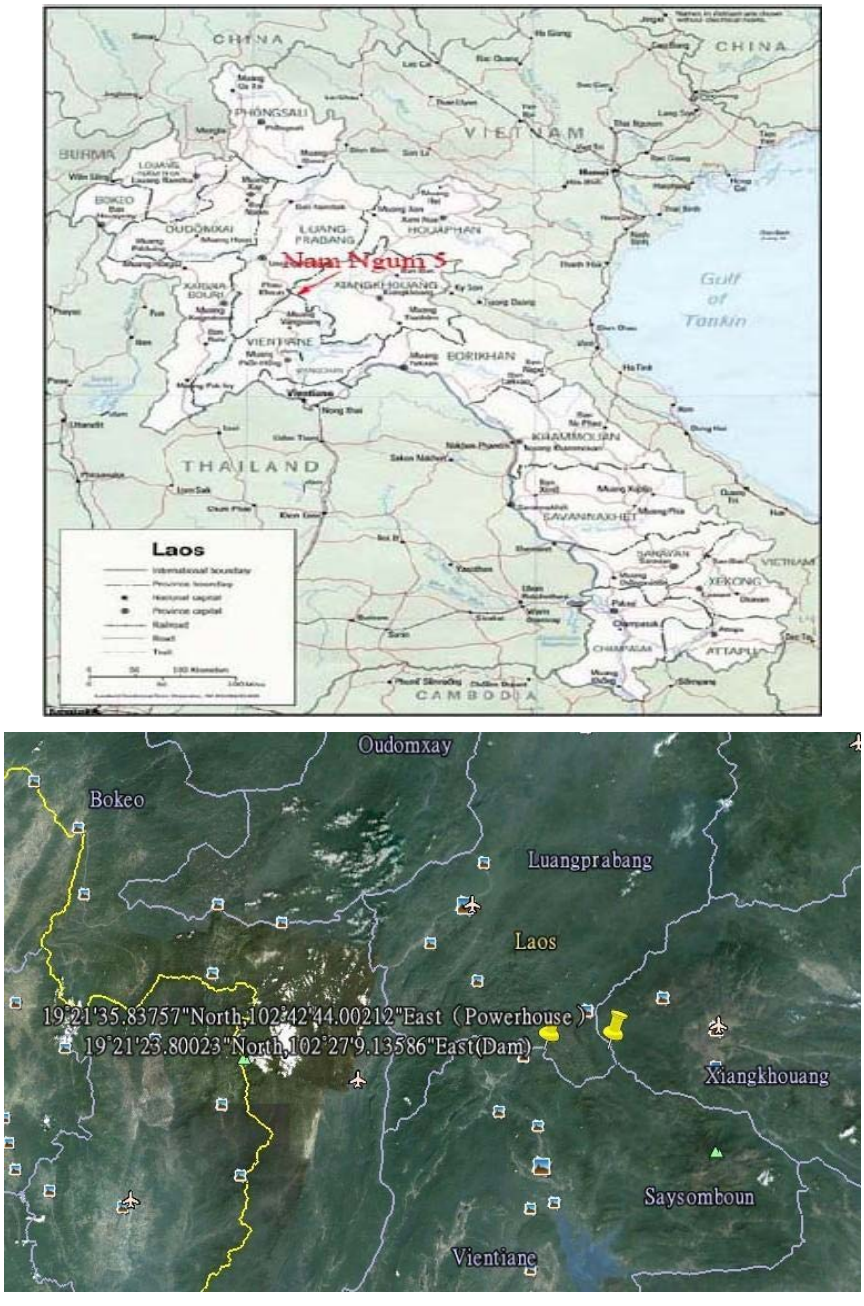


Figure 1.Location of the proposed project

A.4.2. Category(ies) of project activity:

Category 1, energy industries (renewable sources)

Subcategory: hydropower

A.4.3. Technology to be employed by the project activity:

The proposed project is a newly-built hydropower project. There is no equipment and system in operation at the project site prior to the start of the implementation of the proposed project. The baseline scenario is the same as the scenario existing prior to the start of the implementation of the proposed project.

The total installed capacity of the proposed project is 120MW, involving installation of two sets of 60MW hydro turbine and generator unit. The annual electricity supplied to the grid is expected to be 501,930MWh, and the surface area of the reservoir resulted by the proposed project is 14.74km^2. The power density of the proposed project is 8.14W/m^2 which is grater than 4W/m^2 and less than 10W/m^2.

The main constructions of the proposed project include dam, diversion tunnel and power plant. The designed operation period of the proposed project is 25 years. The major parameters of water turbines and generators are as follows:

Table 1 The parameters of equipments adopted by the proposed project

Water turbine	Model:	HLA981-LJ-232
	Number:	2
	Rated water head:	337m
	Rated speed:	500r/min
Generator	Model:	SF-J60-12/4380
	Number:	2
	Rated power:	60MW
	Power Factor:	0.85
Data source	Equipment purchase contract	

The proposed project is planned to adopt imported technologies, which have been used worldwide and safe on environment and will not result in a negative damage to the ecosystem. It is helpful for advanced technical transfer.

For the information about monitoring, see section B.7.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The renewable crediting period is chosen by the proposed project. In the first renewable crediting period (01/01/2013-31/12/2019), the proposed project will have total emission reductions of about 1,739,507tCO_2e, with annual emission reductions of 248,501tCO_2e.

Year	Annual estimation of emission reductions (tCO_2e)
01/01/2013-31/12/2013	248,501
01/01/2014-31/12/2014	248,501
01/01/2015-31/12/2015	248,501
01/01/2016-31/12/2016	248,501
01/01/2017-31/12/2017	248,501
01/01/2018-31/12/2018	248,501
01/01/2019-31/12/2019	248,501
Total estimated reductions	1,739,507
Total number of crediting years	7
Annual average over the crediting period of estimated reductions	248,501

A.4.5. Public funding of the project activity:

No official development assistant (ODA) from Annex I Parties is involved in the proposed project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

1) Version 13.0.0 of ACM0002[1];

2) Version 02.2.1 of the tool to calculate the emission factor for an electricity system[2];

3) Version 06.1.0 of the tool for the demonstration and assessment of additionality[3].

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology ACM0002 is applicable to the proposed project based on the following reasons:

1) The proposed project is a newly-built gird-connected hydropower project. There was no renewable power plant operated prior to the implementation of the proposed project (greenfield plant);

2) The proposed project will result in the creation of a new single reservoir and the power density of the proposed project is calculated to be 8.14W/m^2, which is greater than 4W/m^2;

3) The proposed project doesn't involve switching from fossil fuels to renewable energy sources at the site of the project activity;

4) It is not a biomass fired power plant.

B.3. Description of the sources and GHG gases included in the project boundary

As prescribed by the methodology ACM0002 (Version 13.0.0) and "Tool to calculate the emission factor for an electricity system" (Version 02.2.1), the spatial extent of the project boundary includes the project power plant and all power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints.

According to the "Tool to calculate the emission factor for an electricity system" (version 02.2.1), if DNA of host country has not published delineation of project electricity system and connected electricity systems, PP should define the project electricity system and any connected electricity system, and justify and document their assumptions in the CDM-PDD.

The proposed project is located in Lao PDR. The DNA of Lao PDR has not published delineation of project electricity system. The DNA of Thailand has delineated its project electricity system as the national grid, but not covering those located in other countries with a trans-national project electricity system. Therefore, the project electricity system of the proposed project is defined in accordance with the clarification of CDM-EB about the "regional" in its 28th meeting (Paragraph 14, meeting report) and the prescribed criteria in "Tool to calculate the emission factor for an electricity system" (version 02.2.1) as follows.

1) Lao Power Grid (LPG) and Thailand Power Grid (TPG) constitute a trans-national electricity system.

According to the Power Purchase Agreement signed with Electricite du Laos (EDL) which is the Laos national power grid company in 2007, the proposed project will be connected with the Lao Power Grid. Lao Power Grid and Thailand Power Grid are interconnected through several high-voltage transmission lines (Page 15 of Electricity Statistics 2010). The electricity exchanged between Lao PDR and Thailand in the recent years is listed as follows:

Item	2009	2008	2007
Lao power exported to Thailand (GWh)[4]	2383.32	2315.43	2230.4
Domestic demand in Lao(GWh)[5]	1901.29	1577.86	1298.41
Lao power imported from Thailand (GWh)[6]	1114.4	772.8	730.86

[1] http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L
[2] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.2.1.pdf
[3] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v6.1.0.pdf
[4] EGAT Annual Report 2009, page 88 & Annual Report 2008, page 104, Electricity Generating Authority of Thailand.
[5] EDL Annual Report 2009, page 17, Electricite du Laos.
[6] EGAT Annual Report 2009, page 89 & Annual Report 2008, page 106, Electricity Generating Authority of Thailand

It is shown from the above table that Lao Power Grid and Thailand Power Grid kept enormous power exchange. Therefore, they have constituted a trans-national electricity system.

2) There was no significant transmission constraint between Lao Power Grid (LPG) and Thailand Power Grid (TPG).

According to "Tool to calculate the emission factor for an electricity system" (version 02.2.1), the following criteria can be used to determine the existence of significant transmission constraints:

a. In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year;

According to the EDL annual report 2008, 2009 and 2010, specify export tariffs and import tariffs per specific power plant or transmission line and the tariffs are the same in these years, implying that the export/import tariffs are pre-fixed, with no existence of the spot market. So the constraint criterion 1 is not fulfilled.

b. The transmission line is operated at 90% or more of its rated capacity during 90% percent or more of the hours of the year.

The load of the transmission lines between Lao Power Grid and Thailand Power Grid is far below 90% of its rated capacity during all the year according to the information provided by the EDL official during on-site interview. Furthermore, to accommodate the steady increase in demand for electricity in Thailand, as early as 1993, Thailand and Lao PDR has signed the Memorandum of Understanding (MOU) to support the development of power projects in the Lao PDR through the supply of electricity to Thailand. The two Governments have extended the MOU several times up to 2007 when the most recent agreement saw the power purchase scheme expanded to cover the supply of 7000 MW of electric power to Thailand by 2015[7]. Hence, Constraint criterion 2 is not fulfilled as both the producing and the consuming country have committed themselves to improve the transmission lines according to the increased power generation in Lao PDR and delivery to Thailand.

3) The DNA of Lao PDR and Thailand have provided LoAs for the proposed project and stated that the proposed project assists Lao PDR and Thailand in achieving sustainable development.

According to the clarification of CDM-EB in its 28th meeting (Paragraph 14, meeting report), the trans-national electricity systems are eligible under ACM0002 and the DNAs of countries in these regions, across which the electric system spans, shall be considered as host Parties and shall provide a letter of approval stating that the project activity assists it in achieving sustainable development.

The DNA of Lao PDR has provided a LoA for the proposed project on 07/11/2011 and the DNA of Thailand has provided a LoA for the proposed project on 04/05/2012, in which it stated that the proposed project assists Lao PDR and Thailand in achieving sustainable development.

In conclusion, Lao Power Grid (LPG) and Thailand Power Grid (TPG) have constituted a trans-national electricity system, and there was no significant transmission constraint between of them. Therefore, the project electricity system of the proposed project should be the regional electricity system consisting of Lao Power Grid and Thailand Power Grid (LPG&TPG).

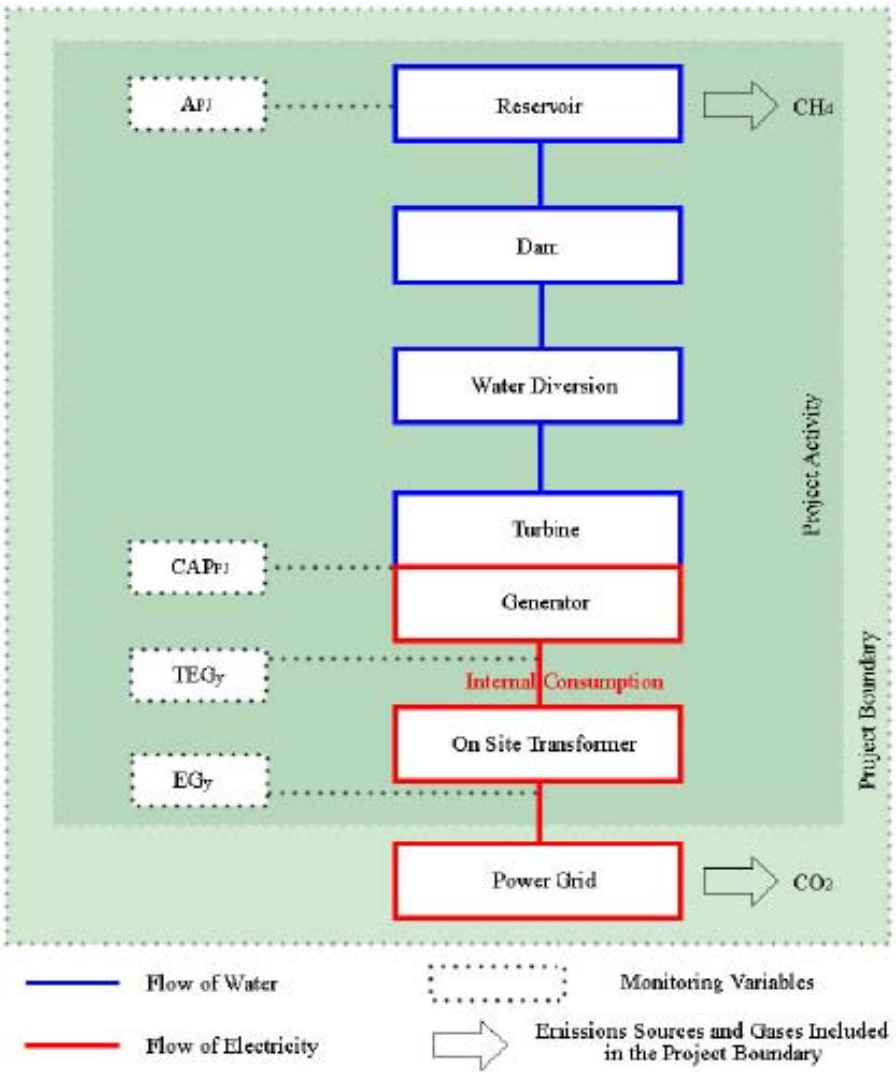
The GHG sources in and out of the project boundary are shown in the following table.

Source		Gas	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	Emissions of CH_4 from the reservoir.	CO_2	No	Minor emission source.
		CH_4	Yes	The power density of the proposed project is 8.14W/m^2, which is grater than 4W/m^2 and less than 10W/m^2.

[7] http://uk.reuters.com/article/2007/10/18/thailand-energy-laos-idUKBKK15938520071018

		N_2O	No	Minor emission source.

The flowchart of the proposed project is as following:



B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to the Identification of the baseline scenario in ACM0002, because the proposed project is a new grid-connected hydropower plant, the baseline scenario is the following:

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

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

In accordance with Guidelines on the demonstration and assessment of prior consideration of the CDM (Version 04), the serious consideration on incentive of CDM is demonstrated as following:

Table 2 Milestones of the proposed project

Date	Milestone	Evidence/Remarks
03/2008	Completion of the feasibility study report(FSR)	FSR

02/04/2008	Board meeting on CDM consideration	Minutes of the board meeting
10/04/2008	Stakeholders meeting on CDM application	Minutes of the stakeholders meeting
06/2008	Completion of Environment Impact Report(EIA)	EIA report
23/06/2008	Approval of EIA	Approval letter of the EIA
09/07/2008	Signing of the equipment purchase contract.	Equipment Purchase Contract
31/08/2008	Signing of the construction contract	Construction contract
22/10/2008	Approval of the FSR	Approval letter of the FSR
21/11/2008	Commencement of construction	Construction permission order
24/03/2009	Signing of the CDM consulting agreement	The CDM consulting agreement
02/2010	Completion of the daft PDD	The daft PDD
03/2010-06/2011	Seeking buyer and DOE	Mails' records
24/06/2011	Signing of the Emission Reductions Purchase Agreement (ERPA)	ERPA
15/10/2011-13/11/2011	GSP	Website of UNFCCC
07/11/2011	LoA of Laos	LoA by Laos DNA
04/05/2012	LoA of Thailand	LoA by Thailand DNA
13/11/2012	LoA of Netherlands	LoA by Netherlands DNA

Starting date of the proposed project

According to "Glossary of CDM terms" (version 06.0), the starting date of a CDM project activity is defined to be the earliest date at which either the implementation or construction or real action of a project activity begins, and in light of the above definition, the start date shall be considered to be the date on which the project participants has committed to expenditures related to the implementation or related to the construction of the project activity. In accordance with above definition, the date of signing equipment purchase contract (09/07/2008) should be the starting date of the proposed project.

Since the starting date of the proposed project is prior to 02/08/2008, it is not necessary to inform the host party designated national authority (DNA) and the UNFCCC secretariat in accordance with "Guidelines on the demonstration and assessment of prior consideration of the CDM" (version 04).

Prior consideration of CDM

The IRR of the proposed project is much lower than the benchmark in the FSR. According to the financial evaluation in the FSR, CDM revenues could help the proposed project become financially viable. Based on the evaluation conclusion, the project owner held the board meeting and decided to develop the proposed project as the CDM project on 02/04/2008.This investment was made before the starting date of the proposed project.

Therefore, CDM was seriously considered in the decision to implement the proposed project.

The continuing and real actions taken to secure CDM status

In accordance with Guidelines on the demonstration and assessment of prior consideration of the CDM (Version 04), CDM consulting agreement, draft version of PDD, letters of authorization, ERPA, and seeking buyer and DOE are all listed in the milestones with the supported evidence, and the time gap between the documented evidences is less than 2 years. Therefore, the continuing and real actions were taken to secure CDM status for the proposed project in parallel with its implementation.

The additionality of the proposed project was demonstrated in accordance with Tool for the Demonstration and Assessment of Additionality (version 06.1.0).

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

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

The proposed project is a new grid-connected renewable plant. The baseline scenario for the new gird-connected renewable plants has been provided already in the methodology ACM0002 as follows:

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

According to the Tool for the demonstration and assessment of additionality(Version 06.1.0), project activities that apply this tool in context of approved consolidated methodology ACM0002, only need to identify that there is at least one credible and feasible alternative that would be more attractive than the proposed project activity, so there is no need to identify other alternatives.

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

The alternative means the continuation of current situation, thus complies with all mandatory applicable legislation and regulations.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method

Tool for the Demonstration and Assessment of Additionality (version 06.1.0) recommends three analysis methods, namely simple cost analysis (Option I), investment comparison analysis (Option II) and the benchmark analysis (Option III).

Since the proposed project can receive revenue from electricity sales, and also can receive revenue from CERs, so Option I simple cost analysis is not appropriate.

The investment comparison analysis (Option II) is only applicable when alternatives are also investment projects. However, the alternative baseline scenario of the proposed project is the grid providing the same amount of power yearly rather than a new investment project, so the investment comparison analysis (Option II) isn't appropriate.

Thus, the benchmark analysis method (Option III) is used for investment analysis.

Sub-step 2b: Apply benchmark analysis

In accordance with *Tool for the Demonstration and Assessment of Additionality (version 06.1.0)*, the Project IRR is used as the financial indicator for the benchmark analysis. According to Guidelines on the Assessment of Investment Analysis (version 05), the local commercial lending rate is the appropriate benchmark for a project IRR. Therefore, the commercial lending rate of Lao PDR is applied as the benchmark for benchmark analysis. The long term commercial loan interest rate published by Bank of the Lao PDR is 9.25% when the FSR was compiling. This commercial loan interest rate has been regarded as the pre-tax benchmark for conservative principle. Therefore, the benchmark project IRR (Pre-tax) is 9.25%.

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

Table 3 Basic financial parameters of the proposed project

Parameters	Unit	Value	Data source
Installed Capacity	MW	120	Approved FSR
Total static investment	Million USD	222.80	Approved FSR
Annual operation hours	h	4,225	Approved FSR
Annual electricity generation	MWh/y	507,000	Approved FSR
Rate of auxiliary power consumption and line loss	%	1	Approved FSR
Annual supplied electricity	MWh/y	501,930	Approved FSR
O&M cost	Million USD	2.8332	Approved FSR
Depreciation rate	%	3.85	Approved FSR

Rate of residual value	%	3.75	Approved FSR
Residual value	Million USD	9.3958	Approved FSR
Fluid capital	Million USD	0.14	Approved FSR
Royalty payment	%	1	Approved FSR
Financial analysis period	Year	29	Approved FSR
Construction period	Year	4	Approved FSR
Operation period	Year	25	Approved FSR
Grid-in tariff	USD/kWh	$0.04590*(1+1\%)^n$	Approved FSR and PPA

Based on the above parameters, the IRR of the proposed project without taking account of the CERs sales revenue and by taking in account of the CERs sales revenue are calculated and shown in Table 4.

Table 4 Comparison of financial indicators with and without CERs Revenues

	Unit	Without CERs Revenues	Benchmark	With CERs Revenues
IRR (Pre-tax)	%	7.56	9.25	9.30%

Table 4 has shown that the IRR of the proposed project without CERs sales revenue is 7.56%, lower than the benchmark IRR of 9.25%, which means that the proposed project activity has significant financial barriers. Additional CDM revenues would make the project economically viable.

If the CERs sales revenue (if the price is 18USD/tCO_2) is taken into account, the IRR of the total investment of the proposed project will be increased to be 9.30%, which meets the requirement of the benchmark.

Sub-step 2d: Sensitivity analysis:

According to the selection criteria of sensitivity analysis specified in *Guidelines on the Assessment of Investment Analysis (version 05)*, the sensitivity analysis of the proposed project is conducted in terms of the four financial indicators with a variation range over ±10%:

1) Total static investment
2) Annual supplied electricity
3) Grid-in tariff
4) Annual O&M cost

The following table shows the variation of IRR (pre-tax) of the total investment (without CERs revenues) when the four parameters fluctuate from -10% to +10%.

Table 5 IRR sensitivity analysis of the proposed project

Parameters	-10%	-5%	0	5%	10%
Total static investment	8.69%	8.10%	7.56%	7.06%	6.58%
Annual supplied electricity	6.47%	7.02%	7.56%	8.08%	8.59%
Grid-in tariff	6.47%	7.02%	7.56%	8.08%	8.59%
Annual O&M cost	7.68%	7.62%	7.56%	7.50%	7.44%

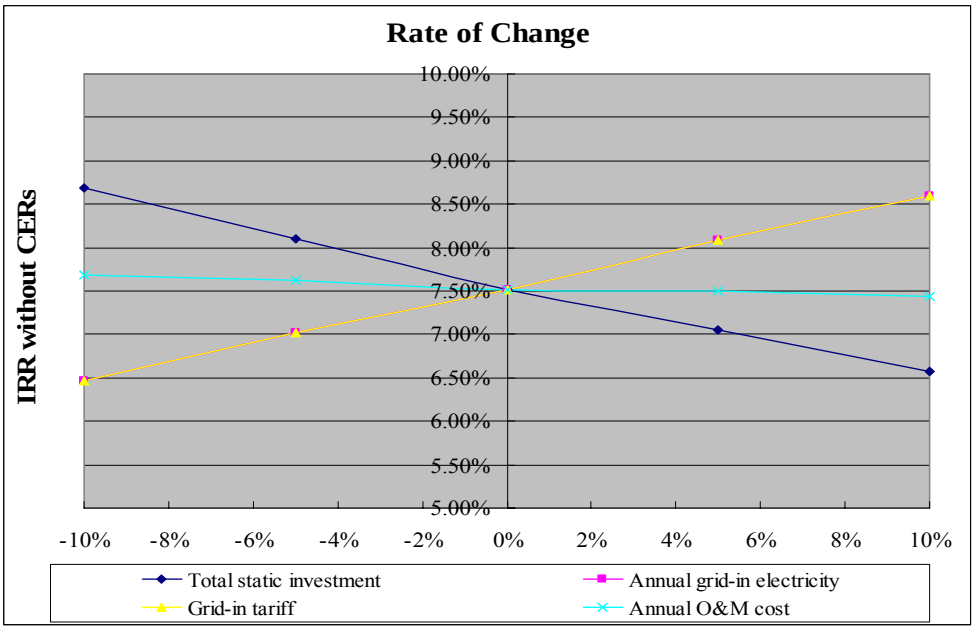


Figure 2 IRR sensitivity analysis of the proposed project

Table 5 and figure 2 have shown that when the four parameters fluctuate between the range of -10% and +10%, IRR of the proposed project can't reach the benchmark.

Table 6 Variations to reach the benchmark of the proposed project

Item	Variation to reach the benchmark of 9.25%
Annual supplied electricity	16.61%
Grid-in tariff	16.61%
Total static investment	-14.41%
Annual O&M cost	Even if it decreases by 100%, the IRR still can not reach the benchmark

Variation of annual supplied electricity

For the proposed project, when the annual supplied electricity increases by 16.61%, the IRR can reach the benchmark.

The plant load factors (PLF) of the proposed project is 48.23%.It was determined based on the long-term hydrological data by the qualified third party-Sinohydro Engineering Bureau 14 Co., Ltd Surveying and Design Research Institute and also approved by the Ministry of Energy and Mines Department of Electricity. The long-term variations of water flow in the flooding and dry seasons have been taken into consideration, so the PLF and the annual supplied electricity of the proposed project are reliable. Thus, the annual supplied electricity of the proposed project is unlikely to be increased by 16.61% during the whole operation period.

Variation of grid-in tariff

For the proposed project, when the grid-in tariff increases by 16.61%, the IRR can reach the benchmark.

The grid-in tariff used in the investment analysis is the same as that in the PPA signed by the project owner and Electricite du Laos. According to the PPA, the grid-in tariff for each year in the whole 25 operation years have been fixed in advance, i.e. the base grid-in tariff is 0.0459 USD/KWh at the year of commercial operation date (COD), subjected to 1% of annual escalation for each contract year after COD. The actual fixed tariff for each year from PPA has been adopted in the investment analysis, thus the grid-in tariff is unchangeable.

Variation of the total static investment

For the proposed project, when the total static investment decreases by 14.41%, the IRR can reach the benchmark.

The proposed project is still under construction, the actual total investment is unavailable at present, but according to the available contracts such as the construction contract, equipments purchase contract and so on, the contract prices of construction and equipments of the proposed project is already higher than the budgetary prices in the

FSR. Besides, the project management organization---Sinohydro North Surveying and Designing Institute Co., Ltd. issued the progress report on investment of the proposed project on 05/12/2012. It is stated that the completed total investment is: 203,945,395 USD and + 146,445,502 RMB =203,945,395 + 146,445,502/6.29 =227,227,669 USD, (6.29[8] is the exchange rate of USD and RMB on 05/12/2012). The value of 227.23 million USD has been higher than the estimation 222.80 million USD in the FSR. Furthermore, according to statistical data issued by Laos Statistics Bureau, the industrial prices kept increasing in the recent years[9], therefore, the total static investment of the proposed project is unlikely to be decreased by 14.41%,

Variation of annual O&M Cost

Even if the annual O&M cost decreases by 100%, the IRR of the proposed project still can not reach the benchmark.

The annual O&M cost of the proposed project includes reparation charge, salary and welfare, reservoir maintenance, material cost and miscellaneous cost. According to the data from Laos Statistics Bureau, the prices of the industrial products and consumer products[10] have kept rising up in the past several years, so the annual O&M costs of the proposed project is unlikely to be decreased by 100%.

Step 3.Barrier analysis.

Not applicable (Only step 2 is selected).

Step 4: Common practice analysis

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

The installed capacity of the proposed project is 120MW, thus the applicable output range is from 60MW to 180MW.

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

According to the definition of "applicable geographical area" given in Paragraph 5 of "Tool for the demonstration and assessment of additionality" (Version 06.1.0), the applicable geographical area covers the entire host country as a default. The proposed project is located in Lao PDR, thus, the applicable geographical area is the entire Lao PDR.

The starting date of the proposed project is 09/07/2008. According to "Electricity Statistics in Lao PDR 2010", there are four hydropower projects with the installed capacity in applicable output range from 60MW to 180MW started commercial operation before 09/07/2008:

Item	Project name	Installed Capacity (MW)	Application of CDM
1	Nam Lik 1/2 Hydropower Project	100	Yes
2	Nam Leuk Hydropower Project	60	No
3	Nam Ngum 1 Hydropower Project	155	No
4	Houay Ho Hydropower project	152	No

NamLik 1/2 Hydropower Project has been developed as CDM project[11], so it was excluded. Thus, the number N_{all} is 3.

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

[8] http://www.bankofchina.com/sourcedb/lswhpj/
[9] http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=32&Itemid=33
[10] http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=38&Itemid=39
[11] http://cdm.unfccc.int/Projects/Validation/DB/3TBPNROEG9CQXBHKKD4RGC0FISS2ZX/view.html

On 31/05/1997, the government of Lao PDR promulgated the Law on Electricity. The investment policies of the development of electricity were established at that time. Hence, the investment circumstances for hydropower projects were fundamentally changed since then.

Nam Ngum 1 Hydropower Project has started operation since 1971[12]; Nam Leuk Hydropower Project and Houay Ho Hydropower project have started construction in 1996[13] and 1994[14] respectively, which are much earlier than 31/05/1997. Thus, the number N_{diff} is 3.

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

As analyzed in Step 2 and Step 3, the number N_{all} and N_{diff} are all 3.

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

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

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The calculation of emission reductions by the proposed project is following ACM0002 (Version 13.0.0).

1. Project emissions

According to ACM0002 (Version 13.0.0), the project emissions shall be accounted by using the following equation:

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

Where:

PE_y = Project emissions in year y (tCO_2e/yr)

$PE_{FF,y}$ = Project emissions from fossil fuel consumption in year y (tCO_2e/yr)

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

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

The proposed project is a hydropower project. According to ACM0002 (Version 13.0.0), only the CH_4 emissions from the reservoir shall be accounted for. So:

$$PE_y = PE_{HP,y,} \quad (2)$$

Emissions from water reservoirs of hydropower plants ($PE_{HP,y}$)

According to ACM0002 (Version 13.0.0), the power density of hydropower projects should be calculated by using the following equation:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \quad (3)$$

Where:

PD = Power density of the project activity, in 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

[12] Page 6 of Electricity Statistics 2010
[13] http://www.adb.org/Documents/pcrs/LAO/IN59_02.pdf
[14] http://www.wrm.org.uy/bulletin/80/Laos.html

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 hydro power plants, this value is zero.

The installed capacity of the proposed project is 120MW, and the surface area of the reservoir is 14,740,000m^2, so the power density of the proposed project is 8.14W/m^2 (120,000,000W/14,740,000m^2). According to ACM0002 (Version 13.0.0), the project emission (PE_y) is shall be accounted by using the following equation:

$$PE_{HP,y} = \frac{EF_{Res} \cdot TEG_y}{1000} \quad (4)$$

Where:

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

EF_{Res} = Default emission factor for emissions from reservoirs of hydro power plants in year *y* ($kgCO_2e/MWh$)

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)

2. Baseline emissions

The baseline emissions were calculated as the product of the net electricity exported to the grid and the baseline emission factor.

According to ACM0002 (Version 13.0.0), the baseline emissions are to be calculated as follows:

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

Where:

BE_y = Baseline emissions in year y (tCO_2e/yr).

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

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

Calculation of $EF_{grid,CM,y}$

According to "Tool to calculate the emission factor for an electricity system" (version 02.2.1), there are six steps to calculate the baseline emission factor of the grid. The detailed processes are as follows:

Step 1 Identify the relevant electric power system

As the demonstration in section B.3, the project electricity system of the proposed project is the regional grid consisting of Lao Power Grid and Thailand Power Grid (LPG&TPG). Furthermore, Lao Power Grid and Thailand Power Grid also imported electricity from the neighboring power grids of Malaysia, Vietnam and China. According to Electricity Statistics in Lao PDR 2010 and Annual Report (2008 to 2010) of Electricity Generating Authority of Thailand, the total electricity imported from these countries is very small, and only about 0.18%(2009), 0.35%(2008), 1.57% (2007) of the total electricity generated within the proposed regional grid. It is considered as reasonable to exclude Malaysia, Vietnam and China grids from project electricity system because of the small amount of electricity exchange between them. Thus, they were considered as the connected electricity system, and the electricity imported from these countries been also considered as the electricity imports.

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

The proposed project chooses the "Option I: only grid power plants are included in the calculation".

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

The calculation of the operating margin emission factor (*EFgrid,OM,y*) is based on one of the following methods:

(a) Simple OM; or

(b) Simple adjusted OM; or

(c) Dispatch data analysis OM; or

(d) Average OM.

The simple OM method is applicable if low-cost/must run resources[15] constitute less than 50% of total grid generation in average of the five most recent years. From 2005 to 2009, the proportion of low-cost/must-run resources in the total grid electricity of LPG&TPG are 8.2% in 2005, 9.7% in 2006, 9.4% in 2007 and 8.7% in 2008 and 8.5% in 2009 respectively, far lower than 50%. Therefore, the simple OM method is applicable for the calculation of the operating margin factor.

According to the tool, the emissions factor can be calculated using either of Ex-ante option and Ex-post option. The proposed project chooses the "Ex ante option". The simple OM is calculated ex-ante using a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the first crediting period.

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

As for the chosen simple OM, there are two methods to calculate simple emission factor in this tool:

- Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit;[16] 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.

For data of each power station and power unit is not public available in Thailand, it can't adopt option A. Meanwhile, only hydro and renewable power generation are considered as low-cost / must-run power sources and the quantity of electricity supplied to the grid by these sources is known from "The Study of Emissions Factor for an Electricity System in Thailand 2009" and "Electricity Statistics 2010 in Lao PDR", and off-grid power plants are not included in the calculation. Therefore, option B could be used to calculate OM emission factor.

According to the selected method above, the calculation formula of OM emission factor is as below:

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y} \quad (6)$$

Where:

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

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

$NCV_{i, y}$ = Net calorific value (energy content) of fossil fuel type i in year 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, not including low-cost / must-run power plants / units, in year y (MWh);

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

y= the three most recent years (2007, 2008 and 2009) for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option);

Step 5 Calculate the build margin emission factor

"Tool to calculate the emission factor for an electricity system (version 02.2.1)" provided two methods to calculate BM:

[15] Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

[16] Power units should be considered if some of the power units at the site of the power plant are low-cost/must-run units and some are not. Power plants can be considered if *all* power units at the site of the power plant belong to the group of low-cost/must-run units or if *all* power units at the site of the power plant do *not* belong to the group of low-cost/must-run units.

Option 1. For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex-ante, as described in option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

Option 1 was adopted by the proposed project.

According to the tool, the sample group of power units *m* used to calculate the build margin should be determined as per the following procedure:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently (SET5-units) and determine their annual electricity generation (AEGSET-5-units, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEGtotal, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) (SET≥20%) and determine their annual electricity generation (AEGSET-≥20%, in MWh);

(c) From SET5-units and SET≥20% select the set of power units that comprises the larger annual electricity generation (SETsample).

Table 7-1 Electricity generation by the most recently built power plants(AEGSET-5-units)[17]

Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
Xeset 2 hydropower plant(Unit 1&2)	74.91	5/8/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited(RPCL)(Unit 1&2)	8,153.26	1/7/2008
Summary	19,041.86	
Percentage as of 2009 Grid Generation	13.01%	

Table 7-2 Electricity generation by the most recently built power plants(AEGSET-≥20%)[18]

Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
Xeset 2 hydropower plant(Unit 1&2)	74.91	5/8/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited(RPCL)(Unit 1&2)	8,153.26	1/7/2008
Gulf Power Generation Co., Ltd. (Unit 1&2)	9,338.68	1/3/2008

[17] The Study of Emissions Factor for an Electricity System in Thailand 2009
Electricity Statistics in Lao PDR 2010

[18] The Study of Emissions Factor for an Electricity System in Thailand 2009
Electricity Statistics in Lao PDR 2010

BLCP Power Co., Ltd. (Unit 1&2)	10,018.13	1/2/2007
Summary	38,398.67	
Percentage as of 2009 Grid Generation	26.24%	

The first option (AEGSET-5-units) can generate 19,041.86GWh which is less than the second option (AEGSET-≥20%) of 38,398.67GWh, thus the second option (AEGSET-≥20%) is chosen.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (7)$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh);

$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh);

$EF_{EL,m,y}$ = CO_2 emission factor of power unit m in year y (tCO_2/MWh)

m = Power units included in the build margin;

y= Most recent historical year for which power generation data is available.

Step 6 Calculate the combine margin emission factor

CM emission factor is weighted average OM margin emission factor and BM margin emission factor:

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

Where:

$EF_{grid,CM,y}$ = Combined margin CO_2 emission factor for grid connected power generation in year y (tCO_2/MWh)

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh);

$EF_{grid,OM,y}$ (i.e. $EF_{grid,OM,simple,y}$) = Operating margin CO_2 emission factor in year y (tCO_2/MWh);

W_{OM} = Weighting of operating margin emissions factor (%);

W_{BM} = Weighting of build margin emissions factor (%);

In this PDD for the first crediting period, the weights w_{OM} and w_{BM} are 50%.

Calculation of $EG_{PJ,y}$

The proposed project is a newly-built project, according to ACM0002 (Version 13.0.0), then:

$$EG_{PJ,y} = EG_{facility,y} \quad (9)$$

Where:

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

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

The project is likely to import the electricity from the grid in case of equipment shutdown or overhaul. Then the net quantity of electricity supplied will be calculated as follows:

$$EG_{PJ,y} = EG_{facility,y} = EG_{facility\ to\ grid,y} - EG_{grid\ to\ facility,y} \quad (10)$$

Where：

$EG_{facility\ to\ grid,y}$ = quantity of exported electricity from the proposed project to the grid in year y;

$EG_{grid\ to\ facility,y}$ = quantity of imported electricity from the grid to the proposed project in year y.

According to ACM0002 (Version 13.0.0), in base of calculation of $EF_{grid,\ CM,\ y}$ and $EG_{PJ,\ y}$ above, calculation method of the proposed project baseline emission is as follows:

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

$$= EG_{facility,\ y} \times EF_{grid,\ CM,\ y}$$

$$= (EG_{facility\ to\ grid,\ y} - EG_{grid\ to\ facility,\ y}) \times EF_{grid,\ CM,\ y} \quad (11)$$

3. Project leakage

According to ACM0002 (Version 13.0.0), no leakage emissions are considered.

4. Emission reductions

$$ER_y = BE_y - PE_y = (EG_{facility\ to\ grid,\ y} - EG_{grid\ to\ facility,\ y}) \times EF_{grid,\ CM,\ y} - \frac{EF_{Res} \cdot TEG_y}{1000} \quad (12)$$

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$NCV_{i,y}$
Data unit:	TJ/Unit
Description:	Net calorific value of the fossil fuel i combusted in grid based power plants used in the determination of the emission factor in year y
Source of data used:	The Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office(TGO)
Value applied:	See Annex 3 for details
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system", the national average default value can be applied. Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)
Any comment:	*reasonable*

Data / Parameter:	$EF_{CO2,i,y}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of fossil fuel type i in year y
Source of data used:	Default values from IPCC 2006
Value applied:	Please refer to Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system", 2006 IPCC defaults can be used; Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)
Any comment:	*reasonable*

Data / Parameter:	$FC_{i,y}$
Data unit:	Million Tonnes, MMSCF, Million Liters
Description:	Amount of fossil fuel type i consumed in the project electricity system in year y
Source of data used:	The Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office(TGO)
Value applied:	See Annex 3 for details
Justification of the choice of data or description of	According to the "Tool to calculate the emission factor for an electricity system", values from government records or official publications can be used;

measurement methods and procedures actually applied :	Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)
Any comment:	

Data / Parameter:	EG_y
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant/unit in year y
Source of data used:	The Study of Emissions Factor for an Electricity System in Thailand 2009, published by the Thailand Greenhouse Gas Office (TGO) and *Electricity Statistics in Lao PDR 2010*.
Value applied:	See Annex 3 for details
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system", values from government records or official publications can be used; Once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option)
Any comment:	

Data / Parameter:	EF_{Res}
Data unit:	kgCO2e/MWh
Description:	Default emission factor for emissions from reservoirs
Source of data used:	Decision by EB23
Value applied	90 kgCO2e/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Decision by EB23
Any comment:	-

Data / Parameter:	Cap_{BL}
Data unit:	W
Description:	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data used:	Project site
Value applied:	0(For new hydro power plants, this value is zero)
Justification of the choice of data or description of measurement methods and procedures actually applied :	Determine the installed capacity based on recognized standards
Any comment:	-

Data / Parameter:	A_{BL}
Data 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 (m^2).
Source of data used:	Project site
Value applied	0 (For the proposed project with a new reservoir, this value is zero.)
Justification of the	Measured from topographical surveys, maps, satellite pictures, etc.

choice of data or description of measurement methods and procedures actually applied :	
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

1. Project emissions

The power density of the proposed project is 8.14W/m^2, larger than 4 W/m^2 and smaller than 10 W/m^2. According to ACM0002, t the project emission (PE_y) is accounted by using the following equation:

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

=507,000MWh*90kgCO_2/MWh/1000=45,630 tCO_2e

2. Baseline emissions

Based on the formula in section B.6.1 and data from section B.6.2, the figures of emission factors of LPG&TPG are as follows:

- $EF_{grid,OM,y}$: 0.6254tCO_2/MWh;
- $EF_{grid,BM,y}$: 0.5467tCO_2/MWh;
- $EF_{grid,CM,y}$: 0.5860tCO_2/MWh.

The annual average grid-connected electricity of the proposed project is estimated to be 501,930MWh, and ex-ante estimated emission reductions, adopt grid-off electricity of the proposed project is zero, therefore, estimated annual average baseline emission is as follows:

$$BE_y = EG_y \times EF_{grid,CM,y} = (EG_{facility\ to\ grid,\ y} - EG_{grid\ to\ facility,\ y}) \times EF_{grid,\ CM,\ y}$$

$$= (501,930-0) \times 0.5860 = 294,131 tCO_2e$$

3. Leakage emissions

No leakage emissions needed to be considered.

4. Emission reductions

Emission reductions (ER_y) are equal to baseline emissions (BE_y) subtract to project emissions (PE_y) and leakage emissions (LE_y), namely:

$ER_y = BE_y - PE_y = 294,131-45,630-0 = 248,501\ tCO_2e$

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
01/01/2013-31/12/2013	45,630	294,131	0	248,501
01/01/2014-31/12/2014	45,630	294,131	0	248,501
01/01/2015-31/12/2015	45,630	294,131	0	248,501
01/01/2016-31/12/2016	45,630	294,131	0	248,501
01/01/2017-31/12/2017	45,630	294,131	0	248,501
01/01/2018-31/12/2018	45,630	294,131	0	248,501
01/01/2019-31/12/2019	45,630	294,131	0	248,501
Total	319,410	2,058,917	0	1,739,507

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$EG_{facility\ to\ grid,\ y}$
Data unit:	MWh
Description:	Electricity exported to the grid by the proposed project
Source of data to be used:	Project activity site
Value of data applied for the purpose of calculating expected emission reductions in section B.6	501,930
Description of measurement methods and procedures to be applied:	Continuous measurement and at least monthly recording
QA/QC procedures to be applied:	Measurement results should be cross-checked against electricity sales receipts.
Any comment:	$EG_{facility,y} = EG_{facility\ to\ grid,\ y} - EG_{grid\ to\ facility,\ y}$

Data / Parameter:	$EG_{grid\ to\ facility,\ y}$
Data unit:	MWh
Description:	Electricity imported from the grid to the proposed project
Source of data to be used:	Project activity site
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0
Description of measurement methods and procedures to be applied:	Continuous measurement and at least monthly recording
QA/QC procedures to be applied:	Measurement results should be cross-checked against electricity sales receipts.
Any comment:	$EG_{facility,y} = EG_{facility\ to\ grid,\ y} - EG_{grid\ to\ facility,\ y}$

Data / Parameter:	$EG_{facility,y}$
Data unit:	MWh
Description:	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data to be used:	Project activity site
Value of data applied for the purpose of calculating expected emission reductions in section B.6	501,930
Description of measurement methods and procedures to be applied:	$EG_{facility,y}$ is calculated as $EG_{facility\ to\ grid,\ y}$ minus $EG_{grid\ to\ facility,\ y}$
QA/QC procedures to be applied:	Refer to $EG_{facility\ to\ grid,\ y}$ and $EG_{grid\ to\ facility,\ y}$ for details.
Any comment:	

Data / Parameter:	TEG_y
Data unit:	MWh
Description:	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y*
Source of data to be used:	Project activity site
Value of data applied for the purpose of calculating expected	507,000

emission reductions in section B.6	
Description of measurement methods and procedures to be applied:	Continuous measurement and at least monthly recording
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	Cap_{PJ}
Data unit:	MW
Description:	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data to be used:	Project site
Value of data applied for the purpose of calculating expected emission reductions in section B.6	120
Description of measurement methods and procedures to be applied:	Verified yearly by the nameplate of water turbine generators
QA/QC procedures to be applied:	-
Any comment:	-

Data / Parameter:	A_{PJ}
Data unit:	m^2
Description:	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data to be used:	Project site
Value of data applied for the purpose of calculating expected emission reductions in section B.6	14,740,000
Description of measurement methods and procedures to be applied:	Measured yearly by the qualified design institute
QA/QC procedures to be applied:	-
Any comment:	-

B.7.2 Description of the monitoring plan:

1. Monitoring team

Monitoring will be carried out by the monitoring team, the organizational structure of the monitoring team and the detailed responsibility of each team member are as below:

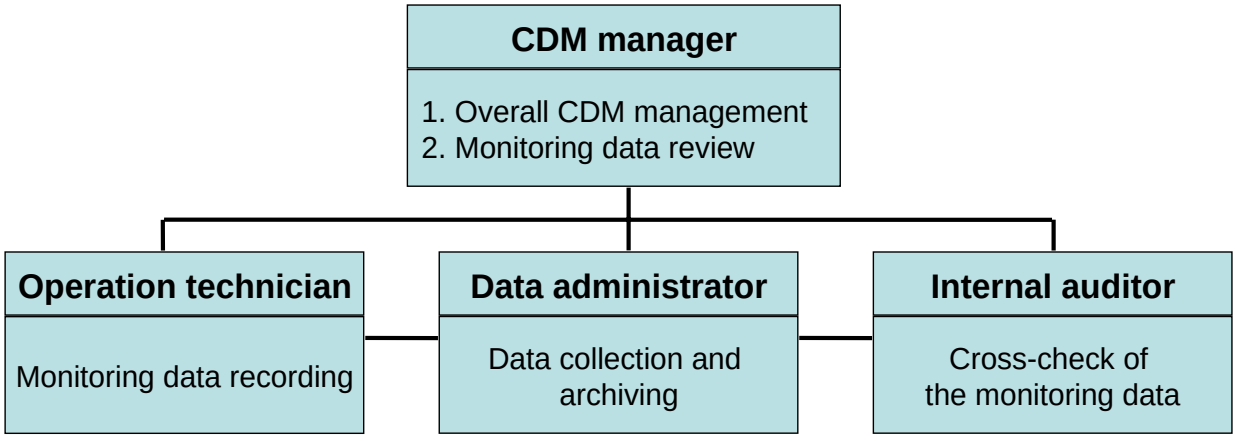
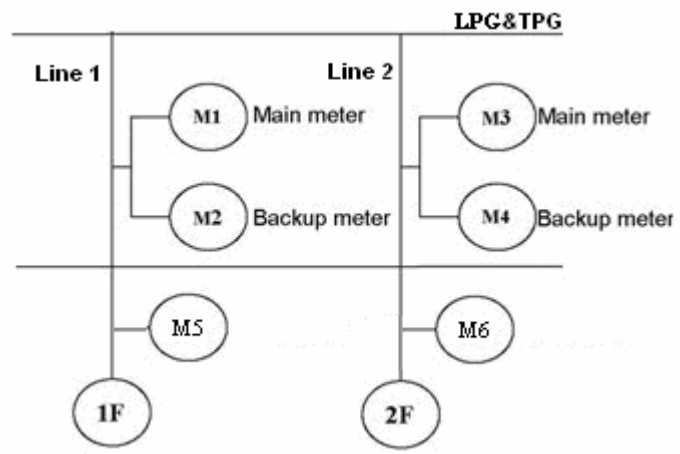


Figure 3 Monitoring management structure

2. Monitoring system

The monitoring equipments are the bidirectional energy meters. The accuracy of meters used to monitoring the electricity exported to the grid and imported from the grid by the proposed project should be 0.2S. The monitoring system Diagram of the proposed project is as follows:



Monitoring system Diagram

The power electricity generated by the proposed project will be supplied to the grid through two transmission lines.

M1 and M2 will be installed on Line 1 at the project site to measure the electricity exported and imported through Line 1; M3 and M4 will be installed on Line 2 at the project site to measure the electricity exported and imported through Line 2. The four meters are all the bidirectional electric energy meters. M1 and M3 are the main meters, M3 and M4 are the backup meter in case of emergency use.

M5 and M6 will be installed at the outlet of the two generators respectively to measure the electricity generated by the two generators. M5 and M6 are the electric energy meters.

3. Calibration

The meters will be calibrated at least once a year by the qualified calibration entity.

4. Internal audit

First, the monitoring data will be reviewed by the CDM manager to ensure the accuracy of the data; after review of the CDM manager, the monitoring data will be forwarded to the internal auditor for the cross-check**.**

5. Emergency procedures

In normal condition, meter records from the main meter are used for ER calculation. In the case of main meter malfunction, the meter records from the backup meter will be used for ER calculation, and the electricity sales receipts will be kept for cross check.

6. Training

The team members of the monitoring team will be trained by the CDM consulting company before the operation of the project as per the monitoring and management manual. If the personnel alternation happens, the new staffs will receive the same training before work.

7. Data management

All of the data records relevant to monitoring such as Power Purchase Agreement, technical parameters of the energy meters, monthly meter records, electricity sales receipts, calibration records, training records and so on will be archived electronically and kept at least for 2 years after the end of the last crediting period.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

The applied study on the baseline and monitoring methodology of the proposed bundled project was completed on 26/11/2012. The entity involved in the study is as follows:

Beijing Haohua Rivers International Water Engineering Consulting Co., Ltd

E-mail: lcm918@vip.sohu.com

Tel: 8610- 63381351

Website: www.hhcdm.com

The above individual and entity are not project participants.

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

09/07/2008[19]

C.1.2. Expected operational lifetime of the project activity:

25 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

01/01/2013 (or the registration date which is later)

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

Not applicable

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

[19] The equipment purchase contract was signed on 09/07/2008, and the construction contact was signed on 31/08/2008, the starting date of the proposed project is the earlier one.

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

According to the approved EIA report and approval letter of the EIA report issued by Water Resource and Environment Agency of Lao People's Democratic Republic, the environmental impacts likely to be caused by the proposed project and the mitigation measures which shall be conducted during the construction and operation phases in order to minimize the negative impacts and ensure the long-term benefits from this project are analyzed as follows:

Potential Environmental Impacts

(1)Construction Period

Dust

There is no any village located close to the construction area including dam site, access roads, powerhouse and others. There is only Ban Chim village located near to the reservoir of the proposed project. However, no any construction activity will be conducted within this area. Therefore, there is no dust will be affected to the local community.

Noise and Vibration

No any village is located close to the construction area. There will be no noise and vibration impact for the local community.

Wastewater

The wastewater during the construction period includes production wastewater and worker's wastewater.

Land use

The land survey, census and asset inventory were conducted by government authority, Village Committees and the project owner jointly. According to Inventory of Land Loss, there was no resettlement resulted by the proposed project, and only 43 households of Ban Chim village were affected due to the land occupation, which includes paddy land, upland land and garden, which includes paddy land, upland land and garden.

(2)Operation Period

Aquatic Habitats

There is no any significant impact on aquatic habitats due to the reservoir is small and lies along the Nam Ting, Nam Sout and Nam Phat rivers and it will be flushed each year. For the existing fish species in the project area, those species which can not live in a lentic environment will migrate to suitable habitats upstream of those three main rivers.

Ground Water

There will be an increase of in the ground water level beside and around the reservoir due to the water level in the reservoir will be raised. However, there is no any village or community center near the reservoir will be benefited from this.

Dewatering Effected of Downstream Diversion

The Dam of the proposed project is located in a relatively remote area which is sparely populated. No requirement on water for agricultural production, neither for irrigation, fishery nor any other uses along Nam Ting River downstream from the Dam site to Powerhouse site.

Preventive and mitigation measures

(1) Construction Period

Dust

The dust along the roads during dry season will be controlled with water spraying in work site, and the respiratory protection devices will prepared for workers at crushing site.

Noise and Vibration

Noise suppression systems will be adopted and the construction time will be strictly controlled to reduce disturbance of wildlife around the construction area.

Wastewater

The sanitation facilities and waste water treatment facilities will be installed. The wastewater will be regularly collected and disposed.

Land use

The affected households has been compensated by cash, land, livestock, or wire fence which equivalent to the amount of land based on agreed standards and relevant national regulations. Monitoring of livelihood restoration will be carried out on the rehabilitated paddy fields and livestock of Ban Chim.

(2) Operation Period

Aquatic Habitats

The monitoring of water quality will focus on the reservoir in order to follow up the progressive improvement of water quality after the impoundment. After all, with the increase of nutrients in the water body, the varieties, quantities and biomasses of plankton flora will also increase, and so will the aquatic fauna. The implementation of the proposed project will change the habitat conditions of the river sections in the reservoir area. The living conditions of bait creatures in the reservoir will be improved slightly, which will be good for development and reproduction of fishes in the reservoir. Therefore, it will create conditions for fishery development for local villagers in the reservoir area. Besides that, fish monitoring will continue in the villages of the lower Nam Ting in order to identify any decrease in Pa Nhoy and other species which could result for the proposed project implemented.

Ground Water

The monitoring of water quality will focus on the reservoir in order to follow up the progressive improvement of water quality after the impoundment. It will provide the basis to identify the occurrence of stratification with deoxygenated bottom layers and to adjust the reservoir management to the observed quality constraints, it any.

Dewatering Effected of Downstream Diversion

Along downstream of the Dam site, there is a small stream joins as a tributary stream of Nam Ting river and at about 2 km further downstream a large tributary stream enters Nam Ting River. The sum of these two inflows is expected to refill and maintain a sufficient minimum flow for domestic and conservation purposes in the reach between the dam site and power house.

Conclusion

The main negative impacts on environment happen due to the construction activities. However, all these impacts will be mitigated by implementing mitigation measures and then will be terminated after accomplishing the construction phase. Preventive and mitigation measures are also planned to conduct during the operation period to reduce and prevent any negative impacts.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

The first stakeholder consultation

During the field survey which carried out initially in May-June 2005 and additional EIA study has been conducted in May 2006, the interviews and consultations with affected villagers and village authorities have been conducted by the Dongsays Company (DSC) study teams for all affected villages within and around the proposed project area. The study teams directly visited each village respectively, and held consultations and interviews with village representatives, and also invited affected villagers to attend the consultation meetings.

Consultation has been conducted in form of discussion and interview. All head of the villages and almost all of the head of the families or households who have affected land were consulted especially the rice paddy field at Ban Chim village. The discussion focused on the attitude of local villagers, regarding the proposed project and its potential impact on current status of land and forest usage, income generation activities, land acquisition, wildlife conditions, resettlement and compensation as well as potential impacts on social, economic and environment.

The second stakeholder consultation

On 10/04/2008, in order to know and collect the views and opinions of the local stakeholders on the construction and CDM application of the proposed project, the project owner held a CDM stakeholder consultation meeting at the project site. The local stakeholders around the proposed project were orally invited to attend the meeting through village committees. In the meeting, the project information was introduced to the stakeholders, and the stakeholders expressed their opinions on the construction of the proposed project. In addition, during this meeting, 30 questionnaires were handed out and all were got back. The questions in the questionnaires are as follows:

1) Do you know the proposed project?

2) What's the necessity of the construction of the proposed project?

3) What's the positive impact of the proposed project to you life?

4) What's the negative impact of the proposed project to you life?

5) Do you support the proposed project as a CDM application project?

E.2. Summary of the comments received:

The first stakeholder consultation

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

Since the impacts and affected land by the Project will be minimal, all of participants agreed the implementation of the Project. Only some participants expressed their willingness to participate in the construction work of the proposed project as labours to get income from the proposed project.

The second stakeholder consultation

The statistic result of the proposed project questionnaires was as follows:

1) On knowing about the project, 17% know it, 80% know it a little, 3% didn't know it;

2) On the necessity of the construction of the proposed project, 57%think it will increase the power supply, 37% think it will promote local employment,30% think it will increase tax revenues;

3) On the positive impact of the proposed project to you life, 43% think they can use electricity or increase power consumption, 37% think it can lower the electricity price, 40% think it can increase income, 43% think it will increase employment opportunities, 50% think it will improve living standards, 40% think it will improve residential environment;

4) On the negative impact of the proposed project to you life, 27% think it will have noise, 53% think it will occupy land,3% think it will destroy the biological environment, 20% think there will be no negative impact;

5) On whether they support the proposed project as a CDM application project,47% think the proposed project meet CDM request and support its application;53% think it is indifferent.

E.3. Report on how due account was taken of any comments received:

The investigation shows that the majority of common people have the supportive attitude towards the construction of the proposed project.

The construction and operation of the proposed project will create some new job opportunities for local resident. The local resident can participate in the construction work, and get income from the implement of the proposed project.

In addition, the Environmental and Social Management Office (ESMO) has been established by the project owner, and is responsible for overall planning, implementation of environmental and social management, resettlement for the project and coordination with local authorities as well as the affected households following the Lao regulations. ESMO has prepared specific Livelihood Restoration Program Work Plan for each year. For example, a number of social action activities for Livelihood Restoration have been undertaken by the ESMO from project commencement until now:

1. Several consultations with affected persons;

2. Installation of two water systems in Ban Xiengdiet, providing clean water to access to each household;

3. Health and physical examination for villagers in Ban Chim;

4. Bridge construction over the Nam Ting River for Ban Namting;

5. Fence construction on access road for Ban Chim preventing death of livestock;

6. Development and training on grievance mechanism and pilot operation;

7. Biogas development to Ban Chim providing energy for cooking and electricity.

In conclusion, these concerns of the public can be solved effectively. It is not necessary to modify design, construction and the run way of this proposed project.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	
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URL:	www.cf-partners.com
Represented by:	CF Partners (UK) LLP
Title:	Investment Advisor for CF Carbon Fund Ⅱ Limited
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No official development assistant (ODA) from Annex I Parties is involved in the proposed project.

Annex 3

BASELINE INFORMATION

The following emission factor calculation refers to the "The Study of Emissions Factor for an Electricity System in Thailand 2009"which was published by the Thailand Greenhouse gas Office （TGO）in 2011 and Electricity Statistics in Lao PDR 2010.

The combined margin emission factor ($EF_{grid,CM,y}$）is calculated as per methodological tool "Tool to calculate the emission factor for an electricity system" version 02.2.1,consisting of the combination of operating margin(OM)and build margin(BM) emission factors as shown in the following steps:

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

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

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

Where:

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

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

$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type i in year 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, not including low-cost/must run power plants/units, in year y(MWh)

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

y = The relevant year as per the data vintage chosen.

Table 1 Quantity of electricity generated and delivered to the LPG&TPG (GWh)[20]

Year	Item	TPG			LPG	Total
		EGAT	IPP	SPP		
2009	Summary	64,102.26	64,840.72	13,971.37	3,427.98	146,342.33
	Non LC/MR	57,155.82	64,840.72	11,811.42	46.97	**133,854.93**
	LC/MR[21]	6,946.44	0	2,159.95	3,381.02	12,487.41
	Thermal	23,463.69	12,388.03	2,225.63	0	38,077.35
	Combined-Cycle	33,164.46	52,452.69	8,752.19	0	94,369.34
	Gas Turbine	309.63	0	833.6	0	1,143.23
	Diesel Engine	1.44	0	0	0	1.44
	Hydropower	6,941.74	0	23.97	3,381.02	10,346.73
	Renewable Energy	4.7	0	2,135.98	0	2,140.68

[20] Electricity report 2007 – 2009/ Electricity Generating Authority of Thailand
Electricity Statistics in Lao PDR 2010
The Study of Emissions Factor for an Electricity System in Thailand 2009

[21] LC/MR power plants include hydropower and renewable energy (including biomass, solar and geothermal power)

	Electricity Import	216.6	0	0	46.97	263.57
2008	Summary	61,287.03	67,420.14	14,092.83	3,724.13	146,524.13
	Non LC/MR	54,359.20	67,420.14	11,904.80	45.77	**133,729.91**
	LC/MR	6,927.83	0	2,188.03	3,678.36	12,794.22
	Thermal	26,778.89	14,398.34	1,996.83	0	43,174.06
	Combined-Cycle	26,449.20	53,021.80	9,029.90	0	88,500.90
	Gas Turbine	659.33	0	878.07	0	1,537.40
	Diesel Engine	2.30	0	0	0	2.30
	Hydropower	6,926.02	0	28.77	3,678.36	10,633.15
	Renewable Energy	1.81	0	2,159.26	0	2,161.07
	Electricity Import	469.48	0	0	45.77	515.25
2007	Summary	65473.71	62233.44	14426.01	3,395.06	145,528.22
	Non LC/MR	57534.09	62233.44	11982.99	25.41	**131,775.93**
	LC/MR	7939.62	0	2443.02	3,369.66	13,752.30
	Thermal	30265	17453.59	2168.76	0	49,887.35
	Combined-Cycle	24124.09	44779.85	8935.6	0	77,839.54
	Gas Turbine	884.2	0	878.63	0	1,762.83
	Diesel Engine	1.17	0	0	0	1.17
	Hydropower	7937.2	0	21.7	3,369.66	11,328.56
	Renewable Energy	2.42	0	2421.32	0	2,423.74
	Electricity Import	2,259.63	0	0	25.41	2,285.04

Note: Since LPG and TPG have been considered as a regional electricity system, the electricity exchanged between LPG and TPG was not included in Electricity Import in Table 1.

Table 2 Amount of fossil fuel consumed by power plants[22]

Year	Fuel type	Unit	TPG			LPG	Total
			EGAT	IPP	SPP		
2009	Natural Gas	scf.	369,146,214,392	459,228,417,361	140,550,086,056	0	**968,924,717,809**
	Lignite	ton	15,818,265	0	0	0	15,818,265
	Bituminous	ton	0	3,645,721	1,840,527	0	5,486,248
	Bunker	liter	111,039,065	38,180,874	8,797,506	0	158,017,445
	Diesel	liter	12,140,891	0	1,685,046	0	13,825,937
2008	Natural Gas	scf.	340,739,529,461	490,866,999,785	145,410,364,035	0	**977,016,893,281**
	Lignite	ton	16,407,465	0	0	0	16,407,465
	Bituminous	ton	0	3,711,791	1,866,776	0	5,578,567
	Bunker	liter	247,441,682	93,212,260	9,555,452	0	350,209,394
	Diesel	liter	6,792,039	43,698,832	1,451,087	0	51,941,958
2007	Natural Gas	scf.	342,335,310,261	454,590,745,280	145,512,075,117	0	**942,438,130,658**
	Lignite	ton	16,060,766	0	0	0	16,060,766
	Bituminous	ton	0	3,692,979	1,889,868	0	5,582,847
	Bunker	liter	785,979,152	144,198,973	6,042,880	0	936,221,005
	Diesel	liter	7,381,996	2,688,851	1,266,337	0	11,337,184

[22]The Study of Emissions Factor for an Electricity System in Thailand 2009
Electricity Statistics in Lao PDR 2010

Table 3 CO_2 emission from electricity generation in the years 2007 – 2009[23]

Year	Fuel Type	Fuel Consumption		Net Calorific Value (MJ/Unit)	Emission factor (tCO_2/TJ)	CO_2 Emissions (tCO_2)
		Unit	Volume			
2009	Total					**82,178,673**
	Natural Gas	scf.	968,924,717,809	1.02	54.3	53,664,864
	Lignite	ton	15,818,265	10,470.00	90.9	15,054,607
	Bituminous	ton	5,486,248	26,370.00	89.5	12,948,176
	Bunker	litre	158,017,445	39.77	75.5	474,469
	Diesel	litre	13,825,937	36.42	72.6	36,557
2008	Total					**84,083,369**
	Natural Gas	scf.	977,016,893,281	1.02	54.3	54,113,058
	Lignite	ton	16,407,465	10,470.00	90.9	15,615,362
	Bituminous	ton	5,578,567	26,370.00	89.5	13,166,060
	Bunker	litre	350,209,394	39.77	75.5	1,051,551
	Diesel	litre	51,941,958	36.42	72.6	137,339
2007	Total					**83,500,546**
	Natural Gas	scf.	942,438,130,658	1.02	54.3	52,197,878
	Lignite	ton	16,060,766	10,470.00	90.9	15,285,400
	Bituminous	ton	5,582,847	26,370.00	89.5	13,176,161
	Bunker	litre	936,221,005	39.77	75.5	2,811,130
	Diesel	litre	11,337,184	36.42	72.6	29,977

Table 4 OM Emissions Factor (Ex ante option)

Year	CO_2 Emission	Grid Consumption	Three years average emission factor
	tCO_2	GWh	tCO_2/MWh
2009	82,178,673	133,854.93	0.6254
2008	84,083,369	133,729.91	
2007	83,500,546	131,775.93	

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

Table 5-1 Electricity generation by the most recently built power plants[24] **(AEGSET-5-units)**

Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
Xeset 2 hydropower plant(Unit 1&2)	74.91	5/8/2009[25]
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited(RPCL) (Unit 1&2)	8,153.26	1/7/2008
Summary	19,041.86	
Percentage as of 2009 Grid Generation	13.01%	

Table 5-2 Electricity generation by the most recently built power plants (AEGSET-≥20%)

[23]The Study of Emissions Factor for an Electricity System in Thailand 2009

[24]The Study of Emissions Factor for an Electricity System in Thailand 2009
Electricity Statistics in Lao PDR 2010

[25] Please refer to http://www.norinco.com/c1024/english/newscenter/content_87.html

Power Unit	Grid Generation (GWh)	COD
Bangpakong Power plant (Unit 05)	1,918.11	16/9/2009
Xeset 2 hydropower plant(Unit 1&2)	74.91	5/8/2009
South Bangkok Power Plant (Unit 03)	4,745.32	1/3/2009
Chana Power Plant (Unit 01)	4,150.26	15/7/2008
Ratchaburi Power Company Limited(RPCL) (Unit 1&2)	8,153.26	1/7/2008
Gulf Power Generation Co., Ltd. (Unit 1&2)	9,338.68	1/3/2008
BLCP Power Co., Ltd. (Unit 1&2)	10,018.13	1/2/2007
Summary	38,398.67	
Percentage as of 2009 Grid Generation	26.24%	

The first set (AEGSET-5-units) can generate less electricity than the second set (AEGSET-≥20%), thus the second set (AEGSET-≥20%) is chosen.

Table 6 Fuel consumptions of the most recently built power plants as listed in Table 5[26]

Fuel Type	Fuel Consumption		Net Calorific Value	Emission factor	CO_2 Emissions
	Unit	Volume	MJ/Unit	tCO_2/TJ	tCO_2
Natural Gas	scf.	223,467,679,056	1.02	54.3	12,376,981
Lignite	ton	0	10,470.00	90.9	0
Bituminous	ton	3,645,721	26,370.00	89.5	8,604,321
Bunker	litre	0	39.77	75.5	0
Diesel	litre	3,929,038	36.42	72.6	10,389
Total					20,991,690

Table 7 Calculation of BM emission factor

CO_2 Emission	Grid Consumption	BM Emission Factor
tCO_2	GWh	tCO_2/MWh
20,991,690	38,398.67	0.5467

Step 3: Calculate the baseline emission factor

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

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y} = 0.6254 \times 0.50 + 0.5467 \times 0.50 = 0.5860$$

[26] The Study of Emissions Factor for an Electricity System in Thailand 2009
Electricity Statistics in Lao PDR 2010

Annex 4

MONITORING INFORMATION

No other information.