CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

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SECTION A. General description of project activity

A.1. Title of the project activity:

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Project title: Nam Lik 1-2 Hydropower Project
PDD Version: 01.2
Completion Date: 04/11/2011

A.2. Description of the project activity:

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Nam Lik 1-2 Hydropower Project (hereafter referred to as the "the project") is located on the Nam Lik River, about 50km upstream of the Nam Lik Bridge of Road No.13 at B.HinHeup, northwest of Vientiane city, developed by Nam Lik 1-2 Power Company Limited (the "project entity").

The project is a diversion hydropower station, the construction of the project including dam, reservoir, diversion system, power house and transmission system. The installed capacity of the project is 100MW, with the annual gross power generation of 435,000 MWh.

Following the Lao PDR's electrification policy, the electricity supply falls in short compared to the increased electricity demand. The project is expected to constantly contribute clean energy to the Lao Power Grid. For the Lao Power Grid is connected with the power grid in Thailand, the power supplied by the project will not only meet domestic electricity demand, but also increase the net power export to Thailand and decrease the net power import from Thailand, where the power grid is dominated by thermal power plants. The baseline scenario of the project is continuation of the present situation, i.e. electricity supplied from the power grid. By displacing part of the power generated by thermal power plants, the project is therefore expected to reduction of CO_2 emissions by an estimated 207,512 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;
- The infrastructures were greatly improved. The implementation of water supply program, transportation and electricity system enhancement will bring substantial benefits to local villagers;
- Reduce the local use of firewood displacing by electricity, reduce the damage to the local vegetation;
- The project owner built a new school for the local community, which provides better education condition to the children, improved local education level.
- 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 slowing down the increasing trend of GHG emissions

A.3. Project participants:

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The parties involved in the project are shown in Table A.1:

Table A.1 Project participants

Name of Party involved	Private and/or public entity(ies) project participants	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Lao PDR (host)	Nam Lik 1-2 Power Company Limited (Project owner)	**No**
Thailand (host)	Nam Lik 1-2 Power Company Limited (Project owner)	**No**

The project is located in Lao PDR and is connected to the regional grid which extends across Lao PDR and Thailand. Therefore both of the two countries are listed as host Parties.
For more detailed contact information on participants in the project activities, please refer to Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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The location of the project is in Lao PDR. Therefore under A.4.1.1 only this host country is listed

A.4.1.1. Host Party(ies):

>>
Lao PDR

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

>>
Vientiane Province

A.4.1.3. City/Town/Community etc.:

>>
B.HinHeup City

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

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The project is located on the main stream of Nam Lik River, about 50km upstream of the Nam Lik Bridge of Road No.13 at B.HinHeup, Vientiane province, Lao PDR. The approximate coordinates of the project site is: 18.7897°N, 102.1233°E.

Figure A.1 Show the location of the project:

Figure A.1. Location of the project

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

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The project activity falls under following scope and category:
Sectoral Scope 1: Energy Industries.
Category: Grid-connected electricity generation from renewable energy sources.

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

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

The Nam Lik 1-2 Hydropower Project is a diversion type hydropower project. The total install capacity of the project is 100 MW. The construction of the project includes concrete faced rock-fill dam, auxiliary dam, over-year regulation reservoir, spillway tunnel, flood discharge tunnel, diversion system, power house and transmission system.

The main technical parameters of the project are listed below:

Table A.2. Main Technical Parameters of propose project

Turbine		Generator	
Type	HLY226-LJ-300	Type	SF-J50-28/7000
Quantity	2	Quantity	2
Rated power	51.5 MW	Rated capacity	58.8MVA
Rated head	73 m	Rated voltage	10.5 kV
Rated flow	78.1 m^3/s	Frequency	50Hz
Rated Rotation speed	214.3 r/min	Rated speed	214.3 r/min
Efficiency	94.25	Power factor	0.85(lag)
Lifetime	25 yr	Lifetime	25 yr
Annual equivalent full load operation hour	4350h		
Manufacturer	Hangzhou Resource Power Equipment Co.,LTD		

The power generated by the two generators will be supplied to Ban Don substation and Hin heup substation through 115kV transmission lines respectively and then distributed in Lao Power Grid.

Eight electricity meters will be installed. The meters M1, M4 will be the main meters, installed at the grid access points, to monitoring the input/output electricity at the grid side. The meters M2 and M5 will be the backup meters for M1 and M4 respectively, parallel combined with M1 and M4. When there is anything wrong with the main meters, the backup meters will be adopted. The accuracy of the meters M1~M4 will be 0.2s. Meters M3 and M6 will be installed to monitoring the total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads. The two meters will be installed at the outlet point of the generators. Meters M7 and M8 will be installed at the 22kV backup transmission line and the living area respectively, to monitoring the input electricity. The accuracy will be complied with the relevant regulation and request of the Laos national power grid company (Electricite Du Laos, EDL).

The construction of the project activity will lead to a new reservoir with a power density greater than 4 W/m^2 and less than 10 W/m^2, the main project emissions is due to the CH_4 released from the reservoir. The detailed calculations please refer to section B.6.1.

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

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The project employs the 7-year renewable crediting period, and the estimation of the emission reductions during the first crediting period (from Jun 1st 2012 to May 31th 2018) is listed in Table A.3.

Table A.3 Estimated amount of emission reductions over the chosen crediting period

Year	Estimation of annual emission reductions in tCO_2e
01/06/2012~31/05/2013	207,512
01/06/2013~31/05/2014	207,512
01/06/2014~31/05/2015	207,512
01/06/2015~31/05/2016	207,512
01/06/2016~31/05/2017	207,512
01/06/2017~31/05/2018	207,512
01/06/2018~31/05/2019	207,512
Total estimated reductions (tonnes of CO2 e)	1,452,586
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO2 e)	207,512

A.4.5. Public funding of the project activity:

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

SECTION B. Application of a baseline and monitoring methodology

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

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Baseline methodology:

Approved consolidated baseline and monitoring methodology ACM0002 (Version 12.1, EB 58): Consolidated baseline methodology for grid-connected electricity generation from renewable sources.

This methodology draws upon the following tools:
Tool for the demonstration and assessment of additionality (Version 6.0.0, Annex 21, EB 65), and
Tool to calculate the emission factor for an electricity system (version 02.2.1, EB 63)

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

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

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

i. *The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;*

The project is to install a new hydro power plant and hence comply with the above applicability criterion.

ii. *In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 10 to calculate the parameter* $EG_{facility,y}$*): the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;*

The criterion is not relevant to a new hydro power plant like this project.

iii. *In case of hydro power plants, one of the following conditions must apply:*

- *The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or*
- *The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m2; or*
- *The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4* W/m^2.

The project result in a new reservoir and the power density of 4.35[1]W/ m^2 is greater than the requirement of 4 W/m^2. The project matches with the above applicability criterion.

The methodology is not applicable to the following:

iv. *Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;*

v. *Biomass fired power plants;*

vi. *Hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is less than 4 W/m^2.*

The project does not relevant to the criteria iv to vi, so it is eligible to be developed under ACM0002 (Version 12.1).

"Tool to calculate the emission factor for an electricity system" (Version 02.2.1) 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. Description of the sources and gases included in the project boundary:

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Spatial boundary

The power generated by the project will be supplied to the Lao Power Grid, which connected with Thailand Power Grid through transmission lines. The regional grid consisting of Thailand Power Grid and the Lao Power Grid is adopted as the project boundary.

According to ACM0002 (Version 12.1), 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

[1] The power density is calculated by dividing the submersed area by the installed capacity. The installed capacity of the project is 100 MW; the area of reservoir at full water level is 23,000,000 m2. Therefore, the power density =100,000,000/23,000,000=4.35 W/m2.

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, the following criteria can be used to determine the existence of significant transmission constraints:

i. *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;*

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

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 don not have significant transmission constrain.

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)

	2009	**2008**	**2007**
Lao power export to Thailand[3]	2383.32	2315.43	2230.4
Domestic demand in Lao[4]	1901.29	1577.86	1298.41
Lao power import from Thailand (EDL)[5]	1114.4	772.8	730.86

[2] Information provided by EDL, regarding to the power load of the transmission lines between Laos and Thailand.
[3] EGAT Annual Report 2009, page 88 & Annual Report 2008, page 104, Electricity Generating Authority of Thailand.
[4] EDL Annual Report 2009, page 17, Electricite du Laos.
[5] EGAT Annual Report 2009, page 89 & Annual Report 2008, page 106, Electricity Generating Authority of Thailand.

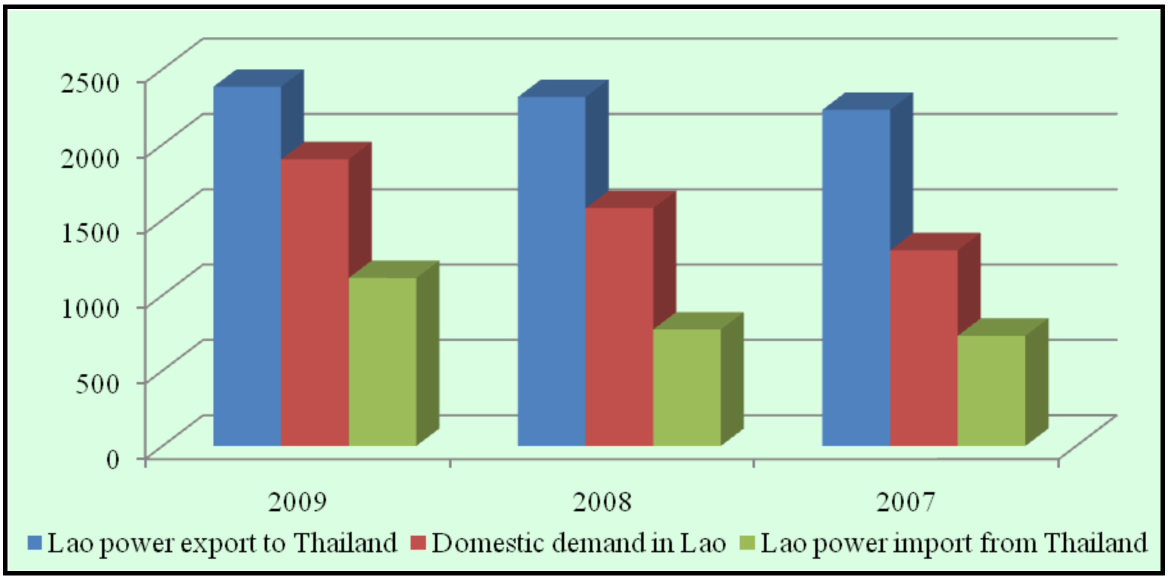

Figure B.1 Power exchange between Lao and Thailand (Unit GWh)

The data listed above indicates the close relationship between the power system of Lao and Thailand. The Thai and Lao power system have kept intimately cooperation, and Thailand government promised that 7,000 MW power will be imported from Lao PDR during 2010 to 2015[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.

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 Board further clarified that trans-national electricity systems are eligible under ACM0002. Furthermore, the Board clarified that the grid emission factor in this context shall be estimated for the "regional electricity system". (EB28, paragraph 14)

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	Gas	Included?	Justification/Explanation
Base line	CO_2 emissions from electricity generation in fossil fuel fired	CO2	Yes	Main emission source
		CH4	No	Minor emission source

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

	power plants that are displaced due to the project activity	N2O	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.	CO2	No	Not applicable to hydro power Project
		CH4	No	
		N2O	No	
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants.	CO2	No	Not applicable to hydro power Project
		CH4	No	
		N2O	No	
	For hydro power plants, emissions of CH_4 from the reservoir.	CO2	No	Minor emission source
		CH4	Yes	Main emission source
		N2O	No	Minor emission source

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

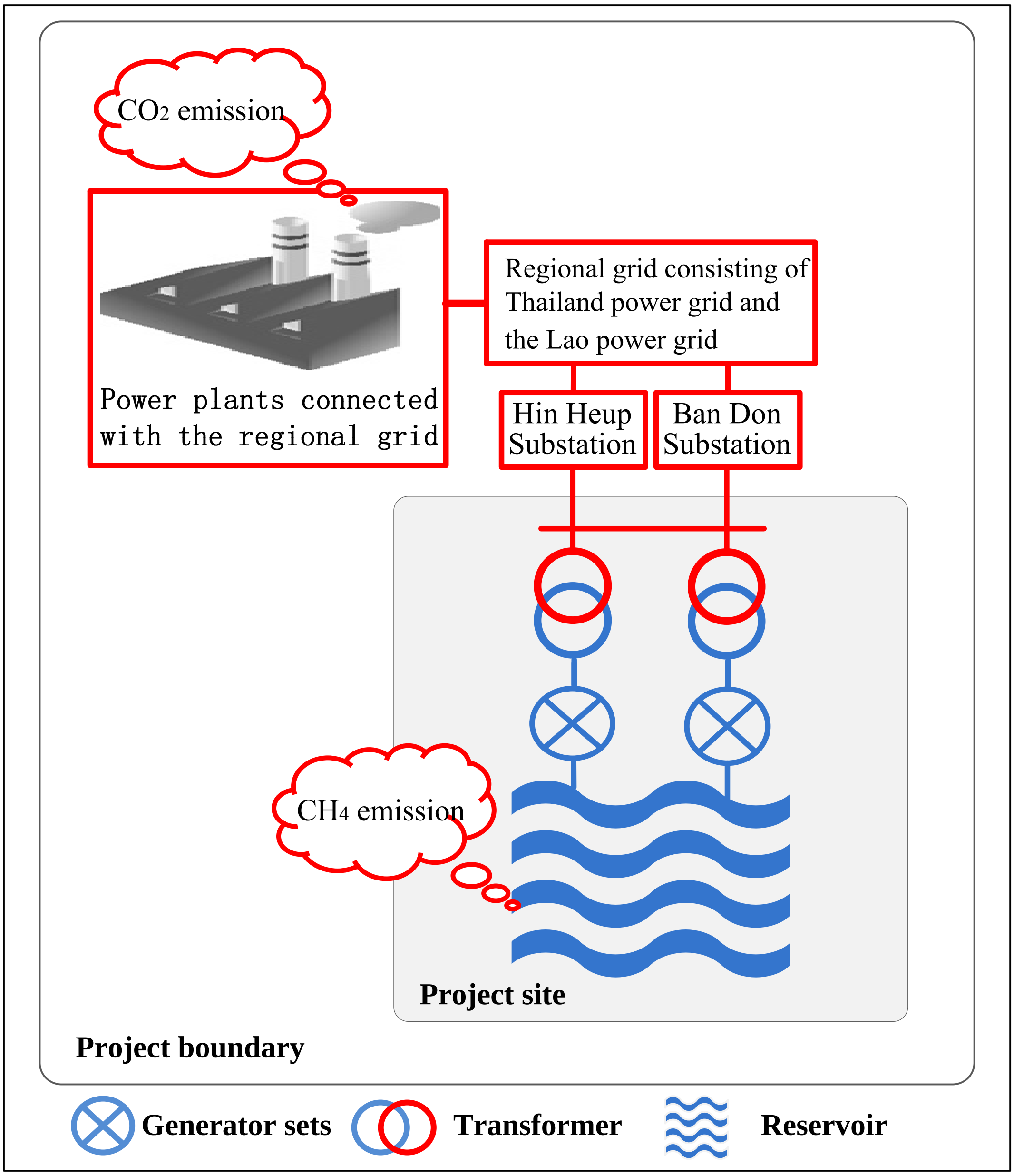

Figure B.2. Flow diagram of the project boundary

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

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According to ACM0002 (Version 12.1), if the project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is the following:

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

The project activity is the installation of a new grid-connected renewable power plant/unit, and is not a modification/retrofit of an existing plant/unit, therefore, the baseline scenario is provision of the equivalent amount of electricity generated by the power plants connected with the regional grid consisting of Thailand Power Grid and the Lao Power Grid, and the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system" (Version 02.2.1).

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):

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Prior consideration of CDM

After signing the concession agreement with government of Lao in October 2006, the project owner decided to seek CDM assistance in middle of 2007 when the project Feasibility Study Report has been completed by independent design institute to overcome financial weakness, and unfavourable conditions that the project encounters. After taking CDM into consideration seriously, the project owner signed the EPC contract in August 2007 which is the earliest date when implementation of the project activity began. The financial analysis shows that the additional support of the CDM makes a significant difference to the project financial status. If the project owner is able to sell CERs generated by the project activity, the additional carbon revenue will make the project financially viable.

The below table 3 shows that continue and real actions were taken to secure the CDM status in parallel with the project construction. In 2007, the project owner started to cooperate with a CDM consultant for the development work, while it is not clear whether the methodology and relevant tools are applicable to the project and there is no successful example for this kind of transnational power grid project. In Oct. 2007, a comparable project with similar situation started GSP while after nearly one year's time, it resubmitted a GSP PDD in Sep. 2008 which shows that there were many potential risk and difficulty for the development of this kind of project.

Furthermore, due to the lack of critical data for emission factor calculation for the regional power grid, the development work for the project was relatively slow. The uncertainty of methodology and lack of successful reference project prevented the project from being attractive for the buyers, especially when the carbon market was seriously affected by the financial crisis in the end of 2008. While the project entity continued to seek establishing cooperation with CER buyers and finally got letter of intent in the beginning of 2009 from one buyer. In May 2009, the term-sheet regarding to the purchase of CER between the project entity and the buyer was signed and the first Lao hydropower project started for GSP. While considering the risk, the buyer didn't sign the final CER purchase agreement with the project entity and withdraw from the project in the end of 2009.

In the beginning of 2010, the first transnational grid project, Dagachhu hydropower project finally got registered at EB which strengthen the confidence of the project entity and buyer to develop the project following the successful procedure under current methodology and tools, the project entity finally sign the emission reduction purchase agreement and submit the application for Lao PDR LoA in 2010.

According to the definition of the "starting date of a CDM project activity" provided in paragraph 67 of EB41 meeting report, the starting date of the Project is determined as 15/08/2007. Before the starting date of the project, the CDM consideration by the chairman of the board was made. During the implementation period, as stated above, continue and real actions were taken to secure CDM status. So the CDM was seriously considered in the decision to implement the project activity.

The timeline of the CDM consideration and continue action of the project entity as follow:

Table B.3. Timeline of the key events

Time	Event
May. 2007	FSR finished by design institute, CER revenue has been taken into account
Jun. 2007	Received service proposal from the first CDM consultant
Jul. 5th 2007	Investment decision was made by the chairman of the board and the incentive of CDM is acknowledged as a key element of the project's profitability
Aug. 15th 2007	**EPC contract has been signed (Starting date of CDM)**
Oct. 30th 2008	Progress report by CDM consultant
Jan. 5th 2009	Received LOI from the buyer
May. 19th 2009	Signed term sheet with the buyer
Dec. 28th 2009	Voluntary withdraw of the buyer
May. 18th 2010	Second buyer contacted with the PO, provided LOI to the PO
Aug. 27th 2010	Conclude an cooperation agreement with the second buyer
Dec. 2010	Submit application for host country approval
Mar. 2011	Update application documents for host country approval
Apr. 2011	Starts GSP

Additionality

According to the "Tool for the demonstration and assessment of additionality" (Version 6.0.0) approved by EB, the additionality of the project is demonstrated and assessed through the following steps.

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

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

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

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

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

CDM financing.

Alternative b) is not a realistic alternative. Lao is lack in oil and natural gas resources, only coal could be produced domestically. 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 Lik 1-2 project in Lao yet, due to the less developed mining industry and transportation system, the condition is limited for thermal power generation development in Lao, till now, the first coal-fired power plant is still under planning, the alternative b) is not a realistic alternative.

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 Lik 1-2 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 6.0.0)*" 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

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

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 6.0.0)*", there are five options for discount rates and benchmarks determine:

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

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

The average value of the 3-Month US Treasury Constant Maturity Rate[8] at the recent 20 years before the starting date (Aug 14th 1987 ~ Aug 14th 2007) 4.61% will be introduced to represents the risk free rate (nominal rate, consistent with the calculation of cash flow) for the following reasons:

i. There is no systematic government bond issue structure in Lao PDR;
ii. The project was accounted in U.S. dollar, and the 3-month U.S. Treasury rate is a widely accepted risk-free rate[9];
iii. The average value in the recent 20 years before the starting date was applied since the long term average value reduces the short term uncertainty and violation of the market..

Regarding the value of national risk premium. The data "Risk premium on lending (prime rate minus Treasury bill rate; %)" provided by World Bank[10] was applied. Risk premium on lending is the interest rate charged by banks on loans to prime private sector customers minus the "risk free" Treasury bill interest rate at which short-term government securities are issued or traded in the market. The data is

[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

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 6.0.0)"*. According to this database, the risk premium of Lao PDR at the decision-making period is 10.1% (2007).

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 14.71% (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.5. Basic parameters of the project

Basic parameters	Unit	Value	Source
Installed capacity	MW	100	FSR
Annual net power supplied	GWh	420.90	FSR
Total investment	Million USD	143.79	FSR
Total static investment	Million USD	121.54	FSR
Average Annual O&M cost	Million USD	2.336	FSR
First year Electricity Tariff	USc	4.68[11]	PPA
Annual escalation	%	1	PPA
Business turnover tax	%	5	FSR
Income tax	%	15	FSR
Minimum tax	%	0.25	FSR
Operation period	year	25	FSR
Construction period	year	3	FSR

The analysis shows that without the revenue of CERs, the IRR of the project will be 11.40%. Much lower than the benchmark 14.71%. The project is not financial attractive. However, considering the CDM revenues, the IRR will be 15.59%, the revenue is able to 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

[11] According to the PPA, when the annual power supply exceeds 435GWh, the tariff applied to the excess power supply will be 60% of the base tariff.

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

Table B.6. Sensitive analysis of the project

Parameters \ IRR \ Variation range	-10%	-5%	0%	+5%	+10%
Fixed assets investment	12.76%	12.06%	11.40%	10.80%	10.24%
Annual O&M cost	11.55%	11.48%	11.40%	11.33%	11.26%
Electricity tariff	10.07%	10.75%	11.40%	12.05%	12.67%
Power supplied to the grid	10.07%	10.75%	11.40%	11.96%	12.34%

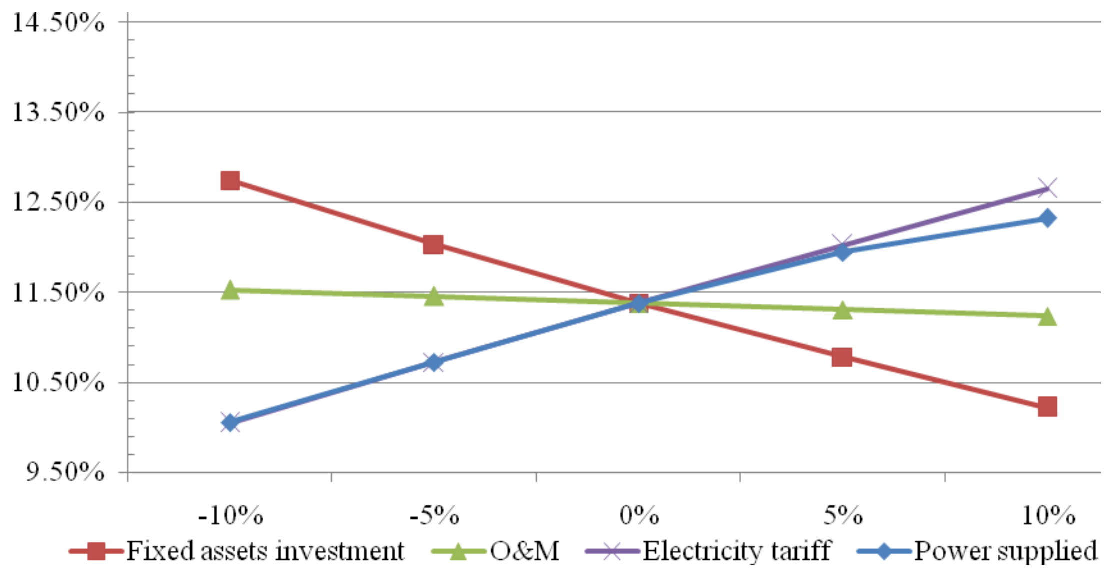

Figure B.3. Sensitive analysis

Furthermore, according to the FSR, annual power generation of the project is calculated based on the long-term hydrological data. However, since Lao is one of LDCs which the development of hydraulic engineering is relatively poor, the longest hydraulic data sequence for the river is only 28 years, it's possible that the actual power supplied fluctuated from the value estimated by the design institute.
To ensure the uncertainty of the estimated power generation due to the poor local hydrological measurement and historical data would not affect the additionality of the project. 40% was selected as the range of sensitivity analysis to fully considering the potential fluctuation of the water flow rate.

Table B.7. Sensitive analysis for power supplied

Variation range	0%	10%	20%	30%	40%
IRR value	11.40%	12.34%	13.08%	13.80%	14.51%

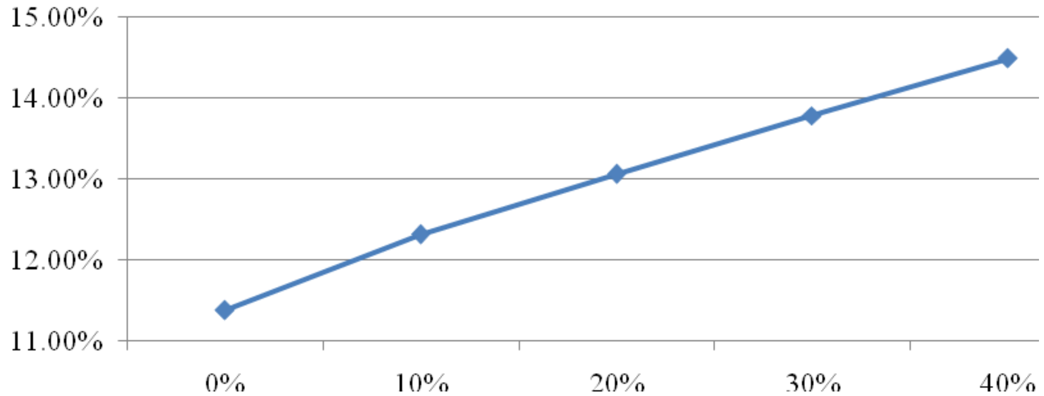

Figure B.4. Sensitive analysis for power supplied

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 former three parameters and 40% increase for the power supplied, 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.

Based on the above analysis, the project IRR could reach the benchmark 14.71% if one of the following conditions can be achieved:

Table B.8. Conditions make the IRR reach the benchmark

Parameters	Overall
Fixed assets investment	-21.80%
Annual O&M cost	-239.00%
Electricity tariff	26.90%
Power supplied to the grid	42.90%

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

1) Regarding the fixed assets investment

The parameters adopted from the FSR that finalized by Kunming Hydroelectric Investigation Design and Research Institute (KHIDI), a qualified third party organization with abundant experiences in hydropower projects design in Southeast Asia. The fixed assets investment estimated in the FSR is in line with local standards on engineering, construction and equipments. In fact, through comparing with the actual signed EPC contract, the total cost for the project is USD 118,858,359, which is about 97% of the static investment estimated in FSR, thus it is unlikely to decrease the investment by such a high percentage.

2) Regarding the annual O&M cost

O&M is not a sensitive parameter. In this project, even if the O&M decreased to zero, the IRR is still lower than the benchmark.

3) Regarding the electricity tariff

The analysis adopted the value in Power Purchase Agreement (PPA) signed between the project owner and the EDL. The PPA has already determined the tariff for each year from the commencing date to the year of 2035, and the tariff is 0.0468USD/kWh (increase by 1% annually), since the PPA has been signed before the starting of the project and it was available at the time of investment decision, thus it is reasonable to applied it in the IRR calculation and it is unlikely to increase it by such a high percentage.

4) Regarding the power supplied

The power supply is determined by the KHIDI according to a relative long-term local hydrological data. There may exist fluctuations and uncertainty among the practical situation in each operational year regarding to the precipitation and runoff of the river, but the space of fluctuation would be limited, especially considering that the reservoir of the Project has over-year regulation ability. That is unlikely to deviate from the long-term hydrological data by 42.90% annually.

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

Step 3 Barrier analyses

This step is not adopted.

Step 4 Common practice analyses

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

As per *Tool for the Demonstration and Assessment of Additionality*, projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory frame-work, investment climate, access to technology, access to financing, etc. According to the *Guidelines On Common Practice (version 01),* common practice analysis is presented through the following 4 steps.

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

The installed capacity of Nam Lik 1-2 Hydropower Project is 100MW, the projects with capacity ±50% of the project (50~150 MW) are considered as similar size.

Step 2: 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.

The regulatory policies, investment environment and hydrology conditions are different by countries, therefore, Lao PDR where the project located is selected as the applicable area for common practice. Projects located in Lao PDR with installed capacity of 50~150MW, which started commercial operation before the starting date of the project are selected for further analysis. According to Electric Power Plants in Laos[12], there is only 1 project observed fulfil the criteria above.

Table B.9. Similar hydropower projects comparison

Project name	Capacity MW	Commissioning year	Ownership
Nam Leuk	60	2000	State ownership

Refer to the projects listed above, the parameter N_{all} is 1.

Step 3: 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}.

As mentioned in the Table B.9, Nam Leuk hydropower project is invested and operated by the national power utility EDL, the ownership are strikingly different from the Nam Lik 1-2 Project, which is a IPP project developed by foreign investor. As an IPP project with foreign investor, it confronts quite different investment environment while the state owned projects have more favorable conditions. Furthermore, for a state owned project, the purposes of the project development are multiple, not only for profits-seeking, but also for other targets like national electrification, flood protection and upgrade infrastructure etc. Thus only IPP projects were defined as the comparable projects.

In conclusion, Nam Leuk hydropower project faces different investment climate thus can be defined as different technology compare with Nam Lik 1-2 Hydropower project according to the criteria provided by the *Guidelines On Common Practice*, the parameter N_{diff} is 1.

Step 4: 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.

Based on the above analysis, the parameter F representing the share of plants using technology similar to the technology used in the project activity in all plants that deliver the same output or capacity as the project activity, which is calculated by $1-N_{diff}/N_{all}=0$. Since F is less than 0.2, it can be concluded that the project is not a common practice and the project is additional.

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

B.6. Emission reductions:

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B.6.1. Explanation of methodological choices:

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The consolidated methodology ACM0002 (Version 12.1) is applied in the context of the project in the following four steps:

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[12] Published by EDL
http://www.poweringprogress.org/index.php?option=com_jotloader&task=files.download&cid=376

- **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:

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

Where:

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

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

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

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

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:

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

Where:

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

EF_{Res} = Default emission factor for emissions from reservoirs, and the default value as per EB23 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

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

The PD of the project activity is calculated as follows:

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

Where:

PD = Power density of the project activity (W/m^2)

Cap_{PJ} = Installed capacity of the hydro power plant after the implementation of the project

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

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:

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

Where:

BE_y	=	Baseline Emissions in year y (tCO_2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year y

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

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

The emission coefficient (measured in tCO2e/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 02.2.1).

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

As we discussed in section B.3, the **project electricity system** is defined as a regional grid consisting of Thailand Power Grid and the Lao Power Grid. And the **connected electricity system** is Malaysia Power

Grid[13].

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

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

According to "Tool to calculate the emission factor for an electricity system" (Version 02.2.1), there are two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.

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

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

According to "Tool to calculate the emission factor for an electricity system" (Version 02.2.1), there are four methods for calculating the $EFgrid,OM,y$:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM

Calculating method (b) simple adjusted OM, would require the annual load duration curve of the grid. However, the relevant information is not publicly available and is difficult to obtain. Therefore, the method (b) is not applicable.

The method (c) requires the detailed operation and dispatch data of power plants in the grid. This data is also not publicly available for the Thailand Power Grid. Therefore, the method (c) is not applicable.

The method (d), average OM, is used when low-cost / must run resources constitute more than 50% of total amount of power generation in the grid. This is not the scenario in the Thailand Power Grid and therefore method (d) is not applicable.

The method a), the simple OM is used where low-cost / must run resources constitute less than 50% of the total grid generation in: 1) average of the five most recent years or 2) based on long-term normal for hydroelectricity production.

The percentage of low-cost/must run resources in the grid is 6.81% in 2005, 8.24% in 2006, 7.83% in 2007, 7.17% in 2008 and 6.92% in 2009[14]. The low-cost / must run resources constitute less than 10% of

[13] According to Electrical Power in Thailand 2006, 2007, 2008, 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. Cambodia, Myanmar, Vietnam and China are not considered as connected electricity system for the power import are small and will not affect the calculation result.
[14] EDL Annual Report, DEDE Electric Power in Thailand.

the total grid generation in the recent 5 years and the simple OM (method a) can be used. Thus, method (a) is applicable to calculate *EFgrid,OM,y*.

For the project, $EF_{grid,OM,simple,y}$ is calculated using ex ante option: a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to DOE for validation, 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 simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

According to “Tool to calculate the emission factor for an electricity system” (Version 02.2.1), there are two options based on different data for calculating simple OM:

Option A: Based on the net electricity generation and a CO2 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.

For the project, the necessary data for Option A is not available, so Option B can be used since the quantity of electricity supplied to the grid by low-cost/must-run power sources is known and off-grid power plants are not included in the calculation. There isn’t any nuclear power in the grid at present 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 and off-grid power plants are not included in the calculation, so Option B is used for calculating *simple OM*.

Under this option, the simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not 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:

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

Where:

EFgrid,OMsimple,y	=	Simple operating margin CO2 emission factor in year *y* (tCO2/MWh)
FCi, y	=	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
NCVi,y	=	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
EFCO2,i,y	=	CO2 emission factor of fossil fuel type *i* in year *y* (tCO2/GJ)
EGy	=	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 project electricity system in year *y*

y = The data available in the most recent 3 years

The detailed calculating procedures please refer to Annex 3 of the PDD.

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

In terms of vintage of data, project participants can choose between one of the following two options:

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 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.

The ***Option 1*** is chosen to calculate without requirement to monitor and recalculate the emissions factor during the crediting period.

According to "Tool to calculate the emission factor for an electricity system", the sample group of power units *m* used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(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 ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, 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 AEG_{total} (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 ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

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

In 2009, the total generation of the system under consideration AEG_{total} is 146,036,460 MWh, the annual electricity generation of the set of five power units $AEG_{SET\text{-}5\text{-units}}$ is 19,041,860 MWh, the annual electricity generation of the most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) $AEG_{SET-\geq 20\%}$ is 29,207,292 MWh. The $AEG_{SET-\geq 20\%}$ is the larger one and therefore the sample to determine the BM is calculated based on the $SET_{5\text{-units}}$.

Build Margin emission factor ($EF_{grid, BM, y}$) is calculated by utilizing an *ex-ante* 3 years data vintage for the regional grid consist of Thailand Power Grid and the Lao Power Grid. It 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, *The Study of emission factor for an electricity system in Thailand 2009* published by Thailand DNA provided the power generation and fuel consumption volume of the most recently built power plants, combined with the data of the *EDL Annual Report 2009* published by Electricite du Laos, the BM calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{i} FC_{BM,i,y} \times EF_{CO2,i,y} \times NCV_{i,y}}{\sum_{m} EG_{m,y}} \qquad \text{(Equation B.8)}$$

Where:

EFgrid,BM,y	=	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$\boldsymbol{FC_{BM,i,y}}$	=	Amount of fossil fuel type *i* consumed by the most recently built power plants in year *y* (mass or volume unit)
$\boldsymbol{EF_{CO2,i,y}}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$\boldsymbol{NCV_{i,y}}$	=	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ / mass or volume unit)
EGm,y	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	=	Power units included in the build margin
i	=	All fossil fuel types combusted in power sources by the most recently built power plants in year *y*
y	=	Most recent historical year for which power generation data is available

The table in Annex 3 shows the power plants included in the BM sample group according to the fuel types used and the total power they generate.

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

According to "Tool to calculate the emission factor for an electricity system" (Version 02.2.1), 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.

The weighted average CM method (option A) should be used as the preferred option, and therefore adopted in this project.

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$$ (Equation B.9)

Where:

w_{OM}	=	Weighting of operating margin emission factor (%);
w_{BM}	=	Weighting of build margin emission factor (%).

The weighs w_{OM} and $w_{BM,}$ by default, are 50% (i.e., w_{OM}= w_{BM}= 0.5) for the first crediting period, and w_{OM}= 0.25, w_{BM}= 0.75 for the second and third crediting period.

Calculate the project leakage

No leakage emissions are considered.

Calculate the emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$ (Equation B.10)

Where:

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

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

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Data / Parameter:	***FCi, y, $F_{i,j,y}$***
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 used:	*The Study of emission factor for an electricity system in Thailand 2009*
Value applied:	See Annex 3 for details.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are from Thailand DNA.
Any comment:	

Data / Parameter:	***NCVi,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 used:	*Electric Power in Thailand 2009*
Value applied:	See Annex 3 for details.

Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are from Thailand authorities, DEDE.
Any comment:	

Data / Parameter:	***EFCO2, i,y, EFCO2, i,j,y***
Data unit:	tCO2/TJ
Description:	The CO2 emission factor per unit of fuel *i* in year *y*, or the CO2 emission factor per unit of fuel *i* by province *j* in year *y*
Source of data used:	*2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4*
Value applied:	See Annex 3 for details.
Justification of the choice of data or description of measurement methods and procedures actually applied :	No specific local value available, the value form IPCC 2006, Guidelines for National Greenhouse Gas Inventories was adopted.
Any comment:	

Data / Parameter:	***EGy ,EGm,y***
Data unit:	MWh
Description:	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*.
Source of data used:	*The Study of emission factor for an electricity system in Thailand 2009*
Value applied:	See Annex 3 for details.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are from Thailand DNA, TGO.
Any comment:	-

Data / Parameter:	***EGimport,y***
Data unit:	MWh
Description:	The electricity(MWh) imported from Malaysia Power Grid in year *y*.
Source of data used:	*Electricity report by EGAT (2009, 2008, 2007)*
Value applied:	See Annex 3 for details.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are from Thailand authorities, EGAT.

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
Source of data used:	Methodology ACM0002(Version 12.1) default value,
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	For new reservoirs, this value is zero.
Any comment:	-

Data / Parameter:	CAP_{BL}
Data unit:	MW
Description:	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data used:	*Methodology ACM0002 (Version 12.1)*
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	For new hydro power plants, this value is zero
Any comment:	-

Data / Parameter:	EF_{Res}
Data unit:	$kgCO_2e/MWh$
Description:	Default emission factor for emissions from reservoirs
Source of data used:	*Methodology ACM0002 (Version 12.1)*
Value applied:	90 $kgCO_2e/MWh$
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

Data / Parameter:	$FC_{BM,i,y}$
Data unit:	mass or volume unit
Description:	Amount of fossil fuel type *i* consumed by the most recently built power plants in year *y*

Source of data used:	*The Study of emission factor for an electricity system in Thailand 2009*
Value applied:	See Annex 3 for details.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data used are from Thailand DNA, TGO.
Any comment:	-

B.6.3. Ex-ante calculation of emission reductions:

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Project emission

$$PE_y = PE_{HP,y} = \frac{EF_{Res} \cdot TEG_y}{1000} = 90*435{,}000/1000 = 39{,}150 \text{ tCO}_2\text{e}$$

Baseline emission

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

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y} = 0.58604 \text{ tCO}_2\text{e/MWh.}$$

The baseline emission of the project:

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y} = 420{,}900 \times 0.58604 = 246{,}662 \text{ tCO}_2\text{e}$$

Project leakage

No leakage emissions are considered.

Emission reductions

$$ER_y = BE_y - PE_y = 246{,}662 - 39{,}150 = 207{,}512 \text{ tCO2e}$$

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

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Table B.10. Ex-ante estimation of emission reductions

Year	Estimation of baseline emissions (tCO_2e)	Estimation of project activity emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
01/06/2012~31/05/2013	246,662	39,150	0	207,512
01/06/2013~31/05/2014	246, 662	39,150	0	207,512
01/06/2014~31/05/2015	246, 662	39,150	0	207,512
01/06/2015~31/05/2016	246, 662	39,150	0	207,512

01/06/2016~31/05/2017	246, 662	39,150	0	207,512
01/06/2017~31/05/2018	246, 662	39,150	0	207,512
01/06/2018~31/05/2019	246, 662	39,150	0	207,512
Total (t CO_2e)	1,726,636	274,050	0	1,452,586

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

B.7.1 Data and parameters monitored:

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:	Calculated value
Value of data applied for the purpose of calculating expected emission reductions in section B.5	$EG_{facility,y} = EG_{output,y} - EG_{input,y}$
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	Please refer to $EG_{output,y}$ and $EG_{input,y}$
Any comment:	-

Data / Parameter:	$EG_{output,y}$
Data unit:	MWh
Description:	Electricity supplied by the project to the grid in year y
Source of data to be used:	Measured by meters. $EG_{output,y}$ equals the sum of the output power measured by M1 and M4.
Value of data	420,900 MWh
Description of measurement methods and procedures to be applied:	Continuous measurement and monthly recording
QA/QC procedures to be applied:	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.
Any comment:	-

Data / Parameter:	$EG_{input,y}$
Data unit:	MWh
Description:	The electricity used by the project and input from the grid in year y

Source of data to be used:	Measured by meters. The value is summed up by M7, M8, and the power input power measured by M1, M4.
Value of data	Estimated to be 0 MWh for ex-ante calculation
Description of measurement methods and procedures to be applied:	Continuous measurement and monthly recording
QA/QC procedures to be applied:	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.
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:	Measured by meters
Value of data	435,000MWh
Description of measurement methods and procedures to be applied:	Continuous measurement and monthly recording
QA/QC procedures to be applied:	According to the recommendation by the manufacturer or the regulations of the grid company, meters will be calibrated periodically.
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 onsite witness
Value of data	100 MW
Description of measurement methods and procedures to be applied:	Installed capacity of the project activity will be determined according to installed equipments' nameplates and will be monitored annually. The nameplate will be checked by DOE during verification. Photographic evidence will be made available to the verifier.
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:	Measured annually
Value of data	23,000,000 m^2
Description of measurement methods and procedures to be applied:	The water level of the reservoir will be daily recorded in the operation period. The highest one of water level records within the monitoring period will be used to determine the water surface area of the reservoir by the project owner. Base on the elevation chart of the reservoir, water level records correspond to specific area of the reservoir. With computer-aid design program, the area determined by the record can be calculated annually, thus the data A_{PJ} is achieved.
QA/QC procedures to be applied:	-
Any comment:	-

B.7.2. Description of the 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:

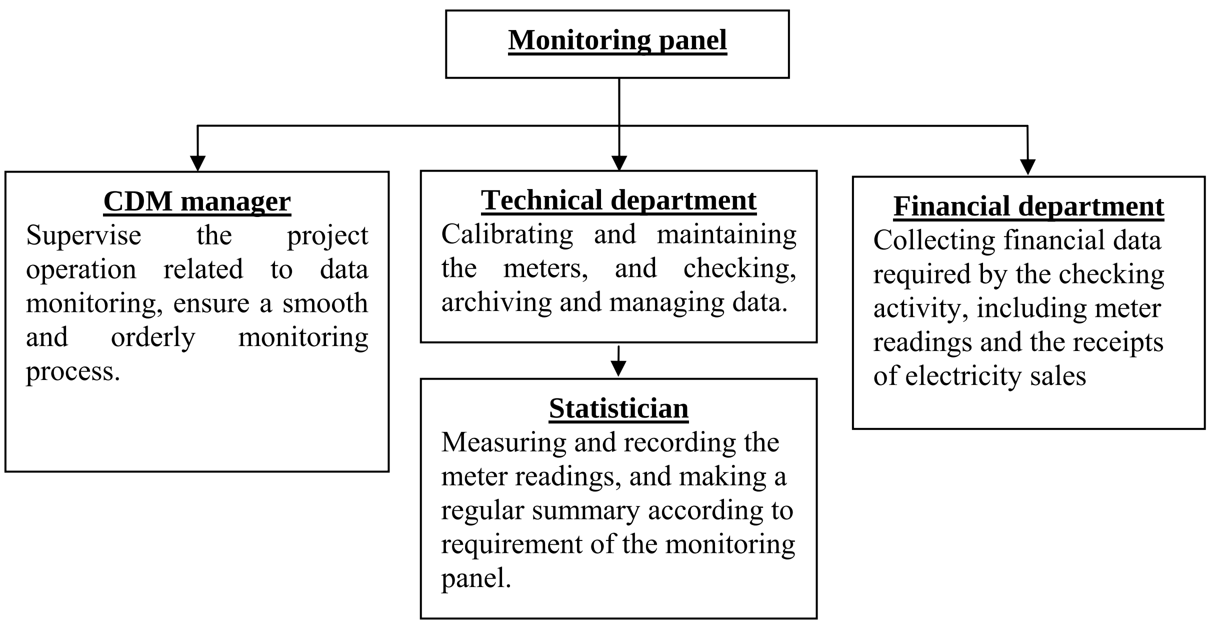

Figure B.4. Organization structure of the monitoring activity

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 examined by the project owner and the power grid company according to the above regulation.

Four meters will be installed to monitoring the input/output electricity $EG_{output,y}$ and $EG_{input,y}$. The meters M1, M4 will be the main meters, installed at the grid access points, to monitoring the input/output electricity. The $EG_{output,y}$ equals the sum of the output measured by M1 and M4. The meters M2 and M5 will be the backup meters for M1 and M4 respectively, parallel installed with M1 and M4. When there is malfunction with the main meters, the backup meters will be adopted. The accuracy of the meters will be 0.2s.

Meters M3 and M6 will be installed to monitoring the TEG_y, i.e. the total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads. The meters will be installed at the outlet point of the generators. The accuracy of the meters will be no less than 0.5.

Meter M7 will be installed to monitoring the power download from the backup 22kV line. And meter M8 will be installed to monitoring the power consumed in the living area. The accuracy of M7 and M8 will comply with the relevant regulation of Lao PDR. And the value summed up of M7 and M8, and the power download measured by M1 and M4 should be considered as the $EG_{input,y}$. The installation status is shown in Figure B.5.

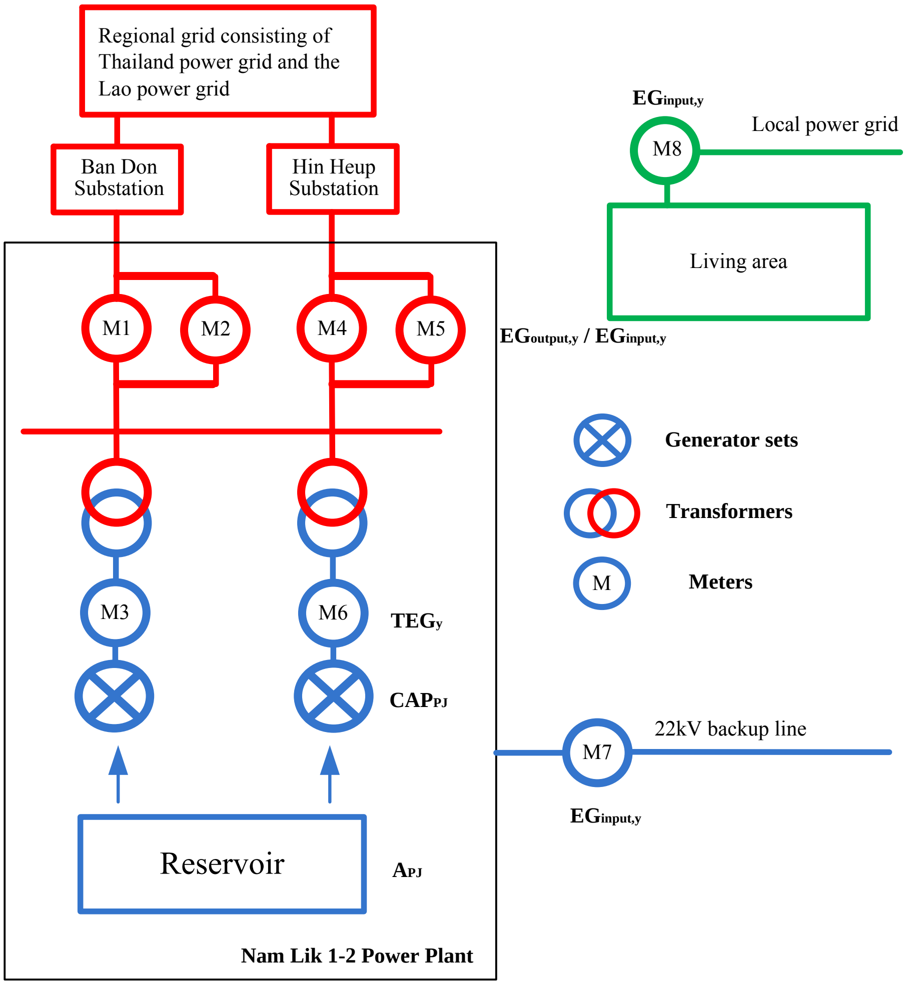

Figure B.5. The monitoring equipment of the project

3. Data collection:

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

a) During the crediting period, both the grid company and the project owner will record the values displayed by the main meter (M1, M4).
b) Simultaneously to step a), the project owner will both record the values displayed by the backup meters (M2, M5).
c) The M3, M6, M7 and M8 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 M2 and M5.
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 & Metering 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. Area of the full reservoir

The surface area will be calculated using the design schematics and area maps. Photographs of the reservoirs at several key locations will be taken when the project becomes operational to check whether the actual reservoirs deviate substantially from the design.

6. 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.

7. Monitoring Report

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

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

>>

Date of completion of baseline and monitoring study: 04/11/2011

Name of persons/entity determining the baseline and monitoring methodology:

Arcticwind Technology Co., Ltd

The entity listed above is not a project participant.

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:

>>
August 15th 2007 (EPC contract has been signed);

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:

>>
01/06/2012 or the registration date whichever is later

C.2.1.2. Length of the first crediting period:

>>
7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
N/A

C.2.2.2. Length:

>>
N/A

SECTION D. Environmental impacts

>>

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

>>

The *Environmental Impact Assessment Report for Nam Lik 1-2 Hydropower Project* was compiled by the Laos National Consulting Company which is qualified for EIA consultancy services and is independent from the project owner. According to this EIA report, environmental impacts caused by the project and the corresponding measures adopted by the project owner for mitigation are as following:

Water Quality

Waste water mainly includes domestic wastewater and soil sediment in water. The domestic wastewater generated during the construction and operation period will be treated in the septic tank, and the sludge will be utilized as fertilizer for farming and forestry instead of being discharged directly into the water system. Excess in soil sediment load in water may occur at the early stage of construction for excavation works. The construction will occur during the dry season that the river flow is low and slow, we may expect that sediment will deposit rapidly and consequently reducing the impacts.

Atmospheric /air impact Assessment

The possible impact on the air quality include: dust and smoke from trucks and heavy equipment engines. The impacts will be temporary and of limited significance if consider the Project is located in a non populated area, several km from the nearest village. Water spraying will be the primary protection measure against dust. Smoke emission from engines can also be controlled by appropriate maintenance of engines.

Noise

Noise will be generated during the construction activity, due to transportation and excavation work. Measures to reduce noise impact will consist in adopting low noise construction equipments and reasonable arrange construction process. Any equipment which generates a high level of noise will be forbidden from operating at night. Moreover, the project owner will try as much as possible to keep workers far from noise sources.

Solid waste

The solid waste includes discarded soil and stone generated during the construction as well as residential garbage. Discarded soil and stone will be collected at special areas and then transported to a waste disposal site. Some discarded stone will be used for local residential housing constructions. Garbage bins present in the construction living area will be used to collect the residential garbage generated during the construction and operation periods. The residential garbage will be regularly sent to a garbage disposal station for landfill.

Ecological impact

According to the investigations implemented during the EIA period, there is rarely any endangered species at the project site. Nam Lik is a small river with low productive in term of aquatic fauna, it plays as habitat for limited species that mainly are small individuals such for Cyprinids. The numbers of species can be increased if spawning and feeding habitats remain keeping exist around the reservoir. The main impact is on the migratory fishes. To protect the migratory fishes, the measure to catch the fishes across the dam in the migratory season will be adopted. Besides, the Nam Lik River is a small secondary tributary of Mekong River (the Nam Lik River is the tributary of Nam Ngum River, and Nam Ngum River is the tributary of Mekong River). The annual average flow of the Mekong River is 16,000m^3/s, while the Nam Lik River is only about 80m^3/s, according to the EIA approved by the Lao government, the implementation applied by the project owner will minimize the impact to the regional biodiversity downstream, the influence of the project to the Mekong River is very limited.

Impacts on land use and land acquisition

According to the EIA and SIA report, there are no villages will be submerged by reservoir impoundment and no village located along the reservoir area. Therefore, no resident resettlement is needed. Although there is no resettlement, there is still farm land, garden paddy field will be occupied due to construction of permanent and temporary camps, quarries and access road. The compensation and benefit agreements are made base on the discussion and interview with the affected people and are in full compliance with relevant national/local laws and regulations.

Erosion

To prevent high sediment loads in water at beginning of rainy season when heavy storm washes out unstable slopes in construction sites, fast-growing trees and grass will be planted in the non-plant slopes. Drain system will be established in the quarry area and slag yard will be covered during rainy season.

Fuel & chemical leakage

The other possible impact on the water quality is accidental fuel leakage. The risk of accidental fuel leakage may be efficiently reduced by the implementation of preventive measures by the contractor: appropriate location of storage areas with drains and collection, collection and destruction of used oils, monitoring of all hazardous products with specific handing procedures and contingency plans.

Impacts on vegetation and forestry

The construction of the project will lead to the submerging of forest, which will lead to the loss of forest products. Before the reservoir submerging, clearing options will be adopted. Large and rare plants will be removed.

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

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:

>>

Both the Host Party and the project participant regard that the proposed project will not bring significant negative impact to the environment. The project could be put into commencement only after the approval of the EIA by local Environmental Protection Administration. The EIA was approved in Feb.18th, 2008.

SECTION E. Stakeholders' comments

>>

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

>>

The Stakeholders Forum was held in a form of series of Public Consultation workshop and information discloses. The participants of the consultation were from different groups including: Representative of government officials at the district, representative of Lao Women's Union at village level, Lao national front for Construction Youth Union at the village level, and head of village and head of household. The process is listed below:

- A village level public consultation has been carried out in December, 2006 at each of seven villages in the project area, the results of this consultation were submitted to SEMU for consideration;
- At the district level, the workshop was held in October 5, 2007 at the district head office;
- At the provincial level, the workshop was held in September 6, 2007 at the Provincial Head Office;
- At the national level, the workshop was held in November 2, 2007.

The stakeholders took part in the workshops, and stated their concerns on the issues on land use, water supply, infrastructure construction, and local cultures. The workshops discussed such topics and put forward corresponding mitigation measures.

Figure E.1. Public Consultation with local villagers

Figure E.2. Stakeholders take part in the Public Consultation workshop

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. 50 questionnaires were distributed and 50 questionnaires were returned.

The profile of the participants of survey is as follows:

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	11	22%
	30~40	17	34%
	40~50	13	26%
	Above 50	9	18%
Gender	Male	32	64%
	Female	18	36%
Education	Elementary school	11	22%
	Junior high school	10	20%
	Senior high school	11	22%
	College and above	18	36%

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 the comments received:

>>

The summary of the questionnaires are as follows:

1) 100% of the respondents agree with the construction of the project.
2) There are 86% of the respondents consider the implement of the project have positive influence on local economic development, and 14% of the respondents consider the implement of the project have no influence on local economic development.
3) There are 72% of the respondents consider the implement of the project can improve the live quality of local residents, and 28% of the respondents consider the implement of the project have no influence on local residents' livelihood.
4) There are 80% of the respondents consider the implement of the project could improve local employment, and 2% of the respondents consider the implement of the project will reduce local employment opportunities, 18% 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, 30% of the respondents worry about the dust produced during the project construction, 14% of the respondents worry about the effect of noise, 18% of the respondents worry about the soil and water conservation problem, 26% of the respondents worry about the effect of solid wastes, and 12% of the respondents worry about the effect to the ecological environment;
6) 26% of the respondents consider the construction of the project will improve local environment condition, 18% of the respondents consider the construction of the project have no influence to local environment and 56% 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.

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

>>

From the questionnaires, it can be known that all stakeholders are in favor of the project activity. Local residents deem that the project activity will bring impact on environment, but in a slight way. Points on the impacts the stakeholders concern (dust, noise, soil and water conservation, solid wastes and ecological environment), the project owner will adopt relevant measures listed in Section D.1. No additional account is required to be taken of the comments received.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Nam Lik 1-2 Power Company Limited was the only project participant, it is authorized by both the government of Lao PDR and Thailand:

Organization:	Nam Lik 1-2 Power Company Limited
Street/P.O.Box:	Ban Saphangmo Meuang Saysettha
Building:	No.250 Unit 13
City:	Vientiane
State/Region:	Vientiane Capital
Postcode/ZIP:	01000
Country:	Lao PDR
Telephone:	+856-21-453253
FAX:	
E-Mail:	
URL:	
Represented by:	
Title:	Manager
Salutation:	Ms.
Last name:	Wang
Middle name:	
First name:	Xingru
Department:	
Mobile:	
Direct FAX:	+86-10-59302960
Direct tel:	+86-10-59302161
Personal e-mail:	wangxingru@cwe.cn

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

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

Annex 3

BASELINE INFORMATION

Calculation of Operating Margin Emission Factor

Annual power generation in Thailand

	EGAT	IPP	SPP	Total
	GWh	GWh	GWh	GWh
Year	2009			
Summary	63,885.66	64,840.72	13,971.37	142,697.75
Non LC/MR	56,939.22	64,840.72	11,811.42	**133,591.36**
LC/MR	6,946.44	-	2,159.95	9,106.39
Thermal	23,463.69	12,388.03	2,225.63	38,077.35
Combined-Cycle	33,164.46	52,452.69	8,752.19	94,369.34
Gas Turbine	309.63	-	833.60	1,143.23
Diesel Engine	1.44	-	-	1.44
Hydropower	6,941.74	-	23.97	6,965.71
Renewable Energy	4.70	-	2,135.98	2,140.68
Year	2008			
Summary	60,817.55	67,420.14	14,092.83	142,330.52
Non LC/MR	53,889.72	67,420.14	11,904.80	**133,214.66**
LC/MR	6,927.83	-	2,188.03	9,115.86
Thermal	26,778.89	14,398.34	1,996.83	43,174.06
Combined-Cycle	26,449.20	53,021.80	9,029.90	88,500.90
Gas Turbine	659.33	-	878.07	1,537.40
Diesel Engine	2.30	-	-	2.30
Hydropower	6,926.02	-	28.77	6,954.79
Renewable Energy	1.81	-	2,159.26	2,161.07
Year	2007			
Summary	63,214.08	62,233.44	14,426.01	139,873.53
Non LC/MR	55,274.46	62,233.44	11,982.99	**129,490.89**
LC/MR	7,939.62	-	2,443.02	10,382.64
Thermal	30,265.00	17,453.59	2,168.76	49,887.35
Combined-Cycle	24,124.09	44,779.85	8,935.60	77,839.54
Gas Turbine	884.20	-	878.63	1,762.83
Diesel Engine	1.17	-	-	1.17
Hydropower	7,937.20	-	21.70	7,958.90
Renewable Energy	2.42	-	2,421.32	2,423.74

Source: The Study of emission factor for an electricity system in Thailand 2009, Table 2, Thailand Greenhouse Gas Management Organization (TGO)

Annual power generation in Lao

	2009	2008	2007
	GWh	GWh	GWh
Summary	**3338.71**	**3716.97**	**3369.64**
Hydropower	3338.71	3716.97	3369.64

Source: EDL Annual Report 2009, 2008, Electricite du Laos

Power import from the connected system

	2009	2008	2007
Total	**217.78**	**586.04**	**2259.63**
Malaysia	217.78	586.04	2259.63

Source: EGAT, Annual Report, 2009, 2008, 2007

Fuel Type		Fuel Consumption		Fuel Specific EF	Net Calorific Value	CO2 Emission	Operating Margin Emission Factor / yr
	Symbol	$FC_{i,y}$		$EF_{CO2,i,y}$	$NCV_{i,y}$	$FC_{i,y} \times EF_{CO2,i,y} \times NCV_{i,y}$	$EF_{grid,OM,simple,y}$
	Unit	Unit	FC/Unit	tCO2/TJ	MJ/Unit	tCO2	tCO2/MWh
	Source		*1*	*2*	*3*	*Calc.*	*Calc.*
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	
Total Generation (incl. import)					**Total (f)**	82,178,673	
133,684.04	**GWh**						
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	
Total Generation (incl. import)						84,083,369	
133,685.33	**GWh**						
2007							
Natural Gas	scf.		942,438,130,658	54.3	1.02	52,197,878	
Lignite	ton		16,060,766	90.9	10470	15,285,400	

Bituminous	ton	5,582,847	89.5	26370	13,176,161	
Bunker	liter	936,221,005	75.5	39.77	2,811,130	
Diesel	liter	11,337,184	72.6	36.42	29,977	
Total Generation (incl. import)				**Total (f)**	83,500,546	
131,722.92	**GWh**					
					Average	**0.62541**

Source:
1. The Study of emission factor for an electricity system in Thailand 2009, Table 3, Thailand Greenhouse Gas Management Organization (TGO)
2. IPCC 2006, Guidelines for National Greenhouse Gas Inventories, Volume 2 Chapter 1 Table 1.4.
3. Electric Power in Thailand 2009, Energy Content of Fuel, Page 42, Thailand DEDE

Calculation of Build Margin emission factor

Plant	Nation	Grid Generation (GWh)	COD
Bangpakong Power Plant (Unit 05)	Thai	1,918.11	16-Sep-09
South Bangkok Power Plant (Unit 03)	Thai	4,745.32	1-Mar-09
Xeset 2	Lao	74.91	2009
Chana Power Plant (Unit 01)	Thai	4,150.26	15-Jul-08
Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	Thai	8,153.26	1-Jul-08
Gulf Power Generation Co., Ltd. (Unit 1&2)	Thai	9,338.68	1-Mar-08
BLCP Power Co., Ltd. (Unit 1&2)	Thai	10,018.13	1-Feb-07
Sum up		**38,398.67**	
Total grid power generation		**146,036.46**	
Percentage of the total grid power generation		**26.29%**	

Source:

The information of the Thailand plants source from The Study of emission factor for an electricity system in Thailand 2009, Table 6, Thailand Greenhouse Gas Management Organization (TGO)

The information of the Lao plants screened by the Electric Power Plants in Laos as of March 2009, Electricite du Laos. And the data is sourceing from the EDL Annual Report 2009, Electricite du Laos.

Fuel Type	Fuel Consumption		Fuel Specific EF	Net Calorific Value	CO2 Emission
	FCi,y		EFCO2,i,y	NCVi,y	FCi,y * EFCO2,i,y x NCVi,y/1000000
	Unit	FC/Unit	tCO2/TJ	MJ/Unit	tCO2
Natural Gas	scf.	223,467,679,056	54.3	1.02	12,376,981
Lignite	ton	0	90.9	10470	-
Bituminous	ton	3,645,721	89.5	26370	8,604,321
Bunker	liter	0	75.5	39.77	-
Diesel	liter	3,929,038	72.6	36.42	10,389
Total					**20,991,690**

Source:
The Study of emission factor for an electricity system in Thailand 2009, Table 7, Thailand Greenhouse Gas Management Organization (TGO)

$$\boldsymbol{EF_{BM}} = 20{,}991{,}690/38{,}398.67/1000$$
$$= 0.54668\ tCO_2e/MWh$$

Calculation of Build Margin emission factor

$$EF_{grid,CM,y} = w_{OM} \times EF_{grid,OM,y} + w_{BM} \times EF_{grid,BM,y}$$
$$= 0.5 \times 0.62541 + 0.5 \times 0.54668$$
$$= 0.58604\ tCO_2e/MWh.$$

Annex 4

MONITORING INFORMATION

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