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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Title: Xeset II Hydropower Project
Version: 1.12
Date: 28/02/2012

A.2. Description of the project activity:

The Xeset II Hydropower Project (hereinafter, the Project)[1] is a 76 MW run-of-river hydropower project under development on the Xeset River in Lao PDR. The Project activity will annually generate approximately 309,000 MWh of renewable energy and supply electricity to the regional grid that covers southern electricity supply area in Lao PDR and the Electricity Generating Authority of Thailand (EGAT) Grid System in Thailand.

The Project is situated upstream of the existing Xeset 1 run-of-river hydropower project (45 MW) and includes the diversion of the Houay Tapoung River to the Xeset River to improve the power generation capacity of the Project. The Xeset II Project results in a new reservoir, located approximately 10 km upstream of the existing Xeset 1 head pond. The reservoir inundation area of Xeset II head pond is 0.18km² at Full Supply Level (FSL), resulting a high power density of 422.2 W/m². The Project is expected to generate an annual energy output of 309,000 MWh[2].

The Project will reduce GHG emissions, by producing renewable energy and displacing part of the electricity in the EGAT Grid System which currently consists of mainly fossil fuel power generation facilities. The Project will avoid approximately 155,983 tonnes of CO_2 e per annum. Xeset II is the first renewable energy project to be implemented under CDM in Lao PDR and will set an important precedent for creating CDM awareness in Lao PDR.

Lao PDR is a Least Developing Country (LDC) and one of the poorest countries in Asia. It is ranked 133 (out of 182) on the United Nations Human Development Index (2009). The narrowly based economy is one of the least developed in Asia with an approximate per capita Gross Domestic Product (GDP) of US$ 701 per annum. The majority of the population is rural and many survive on less than US$2 a day. Renewable energy, especially hydropower development, is seen as a highly appropriate method of achieving sustainable socio-economic development for the country and is an important contributor to Lao PDR's economic growth and national poverty eradication efforts.

[1] 'Xeset 2' and 'Xeset II' are used interchangeably in Lao PDR.

[2] The electricity output of Xeset II was revised to 279,600 MWh after the decision to go ahead with the Project (Final Design Report, November 2005). Based on DOE feedback, the PDD is based on the data that was available during the decision-making process.

The Xeset II Project is expected to contribute to sustainable development through promoting economic and social advancement by providing a reliable and affordable domestic power supply and earning foreign exchange from electricity exports. Broad improvements in the national economy are expected to generate employment opportunities and create wealth and reducing the dependency on "slash and burn" cultivation, poaching, excessive fishing and other unsustainable practices.

An Environmental and Social Impact Assessment consistent with international standards was completed for the Project which identified that the scale of project environmental and social impacts is low due primarily to the project being run-of-river, the small footprint of the construction site, the minor impact on biodiversity and no resettlement required. A detailed Environmental and Social Action Plan was developed to mitigate, manage and monitor impacts. Significant inputs to these studies were derived from extensive community and government consultation and a number of community safeguards established for the Project. These documents were approved by the Government of Lao PDR.

The projected income from the sale of CERs can be expected to assist the project owner, EDL, in implementing the Environmental and Social Action Plan for the Project and more broadly contribute to sustainability and socio-economic initiatives in the region. The Project is expected to contribute to improvements in the livelihood of the local community through increased rural electrification coverage, additional income opportunities, improved road access and health care facilities, and extended water supplies. Only 8% of rural households are connected to the electricity grid, compared to 60% in the capital[3]. The Project will improve access and reliability of electricity supplies thus alleviating one of the major constraints to economic growth and poverty alleviation. Contaminated water is one of the main causes of disease in the Project area and through the provision of clean water supplied through water wells the Project will improve access to safe water and public health in 28 villages. Improved fish production in 33 villages through community fishpond programs will also contribute to improved livelihoods. Community infrastructure has been improved through the Project activity, with 18 villages in the Project area benefiting from healthcare and health education, and improved road accessibility is leading to increased economic opportunities through agricultural activity in the region. Furthermore, the project proponent has committed to providing a portion of the CDM revenue to sustainability initiatives associated with the Xeset II Project.

For Thailand the Project is expected to contribute to progress towards national sustainability goals principally by displacing power which would otherwise be generated from fossil fuel, leading to reduced emissions of greenhouse gases and other pollutants such as sulphur dioxide and ozone depleting gases.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity (ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)

[3] Xeset II Hydropower Project – Environmental and Social Impact Assessment 2004

Government of Lao PDR (Host)	Electricite Du Laos (EDL)	No
Switzerland	Vitol S.A.	No
(*) In accordance with the CDM modalities and procedure, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party (ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Lao People's Democratic Republic ("The Host Country")

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

Saravan Province

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

Laongam District

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

The Project is located on the Xeset River in the province of Saravan in southern Lao PDR (see Figure A-1). The Xeset River is a tributary of the Xedon River, which in turn forms a tributary of the Mekong River. The closest large township is Saravan, which is about 35 km north east of the Project area. The Project is about 100 km east of Pakse on RN 20, which is the main road linking Saravan with Pakse. The geographical coordinates of the Project components are as follows:

- Xeset II powerhouse - 15°29'15.67"N and 106°16'58.87"E.
- Xeset II head pond - 15°24'14.86"N and 106°16'48.20"E.

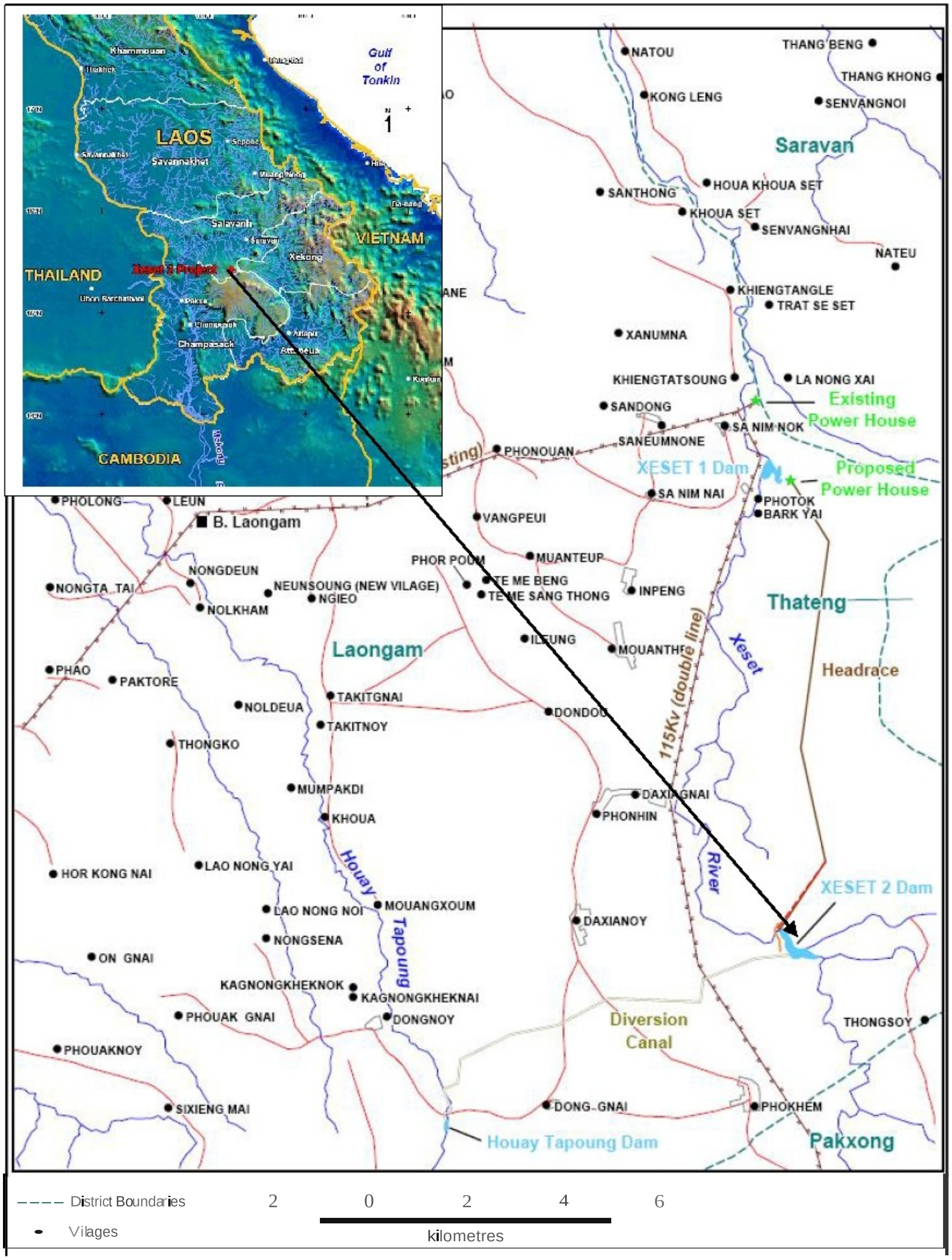

Figure A-1: *Geographical location of Xeset II Hydropower Project.*

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

The Project can be categorised under **Sectoral Scope 1: Energy Industries (renewable / non-renewable sources)**.

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

The Xeset II Hydropower Project is a run-of-river scheme with a gross head of 271 meters and an installed capacity of 76 MW. The surface powerhouse will be equipped with two Francis type turbines with an installed capacity of 38 MW each. Both the generators and turbines are manufactured by Dongfang and the generators have a designed operation lifetime of 30 years[4]. Xeset II is expected to generate an average annual production of 309,000 MWh[5]. According to the hydrological and plant optimisation studies conducted during the feasibility stage, the plant factor for the Xeset II Project is 46.4%[2]. The Power Development Plan for Lao PDR shows that the the Xeset II plant factor is in the range for hydropower plants in Lao PDR which usually have a plant factor of less than 50%[6]. Other existing hydropower plants which are of a similar size to the Xeset II Project in both Lao PDR[7] and Thailand also have plant factors within this range (see Annex 1 for details).

The Project proponent, EDL has employed China North Industries Corporation (Norinco) through a turnkey arrangement to build and supply the equipment for the Xeset II Project[8]. Appropriate training regarding the employed technology, regulations and safety requirements before the start of operations will be conducted by Norinco for EDL staff.

The Project is situated on the upper Xeset River about 10 km above the Xeset 1 head pond (river distances). The Xeset II head pond will collect the flow from both the Xeset and the Houay Tapoung diversion which will enter the head pond on the bank of the Xeset. The Project consists of a concrete overflow dam (114 m long x 23 m high) with an intake structure and two radial flushing gates. The head pond has an active volume of 800,000 m^3 which will be used for daily peaking. The intake is situated on the right bank of head pond and leads to a 1.5 km long open canal with a gated intake, trash rack and trash rack cleaner, a 6.8 km long headrace tunnel with a 19.67 m^2 to 26.30 m^2 cross section, a 1.49 km long steel penstock, a surface powerhouse and a 200 m long tailrace. A vertical surface venting surge tank will be located just upstream of the steel penstock. The combined catchment area for the Xeset II Project is 392 km^2. The powerhouse discharge is 33.7m^3/s.

The powerhouse will drain to the Xeset 1 head pond via a 200 m long tailrace. Access to the powerhouse and associated switchyard will be linked to both the 115kV transmission line to Paksong and connect to Xeset 1 switch yard by a 115 kV line.

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[4] Xeset II Hydropower Project, Technical Document for Approval – guarantee for equipment performance, Norinco

[5] Xeset II Feasibility Study 1999, Xeset II Xeset II Hydropower Development Project Update, February 2004.

[6] Power Development Plan 2005 – 2013, Section 3.3, pIII-6

[7] Power Development Plan 2007 – 2016, Appendix 3-7, Table 3.2.6

[8] EDL-Norinco Finance Contract, 2004

The Xeset II power houses will be connected via a 37 km long double-circuit 115kV transmission line from the switch yard of Xeset II to Paksong. This will be linked to the southern supply area at Chiengxai (Ban Jianjxay) Substation which is presently supplied by Xeset 1 and the Selabam hydro power plant. The linkage will increase reliability and guaranteed electricity supply to the southern Lao and the EGAT Grid System in Thailand. A 3.1 km long 115kV transmission line will link the switch yards between Xeset II and Xeset 1. The Chiengxai Substation will be connected to Bangyo Substation which is in turn connected to the EGAT Grid[9].

Table A-1: ***Main technical parameters of the proposed Project.***

Parameter	Value	Source/Comment
Installed capacity (MW)	76	Xeset II Hydropower Project - Minutes of Model Turbine Acceptance Test (15/6/06) (p6)
Operating time yearly (hours)	4066	Xeset II Feasibility Study 1999, Xeset II Xeset II Hydropower Development Project Update, February 2004.
Water head (m)	271	Xeset II Hydropower Project, Final Design Report, Revised (I),China North Industries Corporation, November 2005
Design flow of the turbine (m^3/s)	16.85	
Expected annual power generation (effective supply to the grid) (MWh)	309,000	Xeset II Feasibility Study 1999, Xeset II Xeset II Hydropower Development Project Update, February 2004.
Plant factor	46.4%	Xeset II Hydropower Project Feasibility Study 1999, Norconsult[10]

[9] Power Development Plan in Lao PDR 2005-2013

[10] p24, 60, 96 of the 1999 Feasibility Study

Table A-2: ***Technical data of the turbine and generator units***

Main Technical Data		Value
Turbines	Units	2
	Type	HLD 336-LJ-193
	Manufacture	DONGFANG
	Rated flow rate	16.85 m^3/s
	Rated water head	271m
	Capacity	38MW
	Type	Francis
Generators	Units	2
	Types	Three-phase synchronous
	Manufacture	DONGFANG
	Capacity	38 MW
	Rated Voltage	11 kV
	Rated current	2346.5 A
	Type	SF38-12/4250

Technology transfer and technology appropriate to local socio-economic conditions

The Project contributes to the technical development of the run of river hydropower sector in Lao PDR. The Project activity utilises imported technology from a Chinese supplier. This technology has been successfully implemented in other countries of the region. The project contributes to the development of expertise and skills in the hydropower sector in Lao PDR.

This is one of few proposed CDM projects in Lao PDR and has contributed to the understanding and implementation of CDM in Lao PDR.

The transfer of technology and ideas from this project will benefit EDL and other companies and individuals from Lao PDR and will contribute to less reliance on external assistance. The technology can be considered best available technology for the hydropower sector with a low environmental and social impact run of river design in preference to an impoundment and major dam structure.

The Project will generate approximately 309,000 MWh of electricity and avoid an average of 155,983 tonnes of carbon dioxide equivalent (CO_2e) per annum. This will result in the transfer of best available technology appropriate for the advancement of local economic and social conditions of Lao PDR. The rapidly growing electricity demand, especially in the south, will be met through clean energy production, displacing grid connected fossil fuels and the reducing dependence on imported electricity.

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

The Project activity is expected to generate an estimated annual emission reduction of 155,983 tCO_2e and a total reduction of 1,091,881 tCO_2e during the first crediting period of the Project (23/09/2011-22/09/2018).

Table A-3: ***Estimated amount of emission reduction over the chosen crediting period.***

Years	**Annual estimation of emission reductions in tonnes of CO_2 e**
2011 (23Sep – 31 Dec)	42,735
2012	155,983
2013	155,983
2014	155,983
2015	155,983
1016	155,983
2017	155,983
2018 (1 Jan – 22 Sep)	113,248
Total emission reductions (tonnes of CO_2 e)	1,091,881
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	155,983

Refer to section B.6.3 for further details on the quantification of GHG emission reductions associated with the Project.

A.4.5. Public funding of the project activity:

The Project did not receive any public funding from Parties included in Annex I of the UNFCCC for the construction of the project. The Norwegian Agency for Development Co-operation (NORAD) provided funding for the initial feasibility assessment of the Project.

SECTION B. Application of a baseline and monitoring methodology

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

Version 12.1.0 of ACM0002 (Consolidated methodology for grid-connected electricity generation from renewable sources).

Version 5.2 of the tool for the demonstration and assessment of additionality.

Version 02.1.0 of the tool to calculate the emission factor for an electricity system.

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

The Methodology ACM0002 (Version 12.1.0) is applicable to the proposed Project due to the following reasons:

- The Project is a grid connected renewable electricity generation project, in the form of a run-of-river hydroelectric project which is connected to a regional and international electricity system (combined electricity supply area in Southern Lao PDR and the EGAT power grid);
- The Project activity is the installation of a new run-of-river hydropower plant;
- The Project activity results in a new reservoir and the power density of the Xeset II Project is 422.2 W/m² (see B.6.1). This is greater than the methodology threshold of 4 W/m²; and
- The Project does not involve switching from fossil fuel to renewable energy at the Project site.

Therefore, the approved methodology ACM0002 (Version 12.1.0) is applicable to the proposed Project activity.

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

According to methodology ACM0002, 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. The Project boundary is the Project site, the Southern Supply Area and EGAT Grid System (GS) with its extension into Lao PDR.

The CDM Executive Board (EB) in its 28th meeting in December 2006[11], clarified that the word "regional", in context of "regional electricity system" used in ACM0002, can also be interpreted as extending across international boundaries. The Board further clarified that trans-national electricity systems are eligible under ACM0002 and that the grid emission factor in this context shall be estimated for the "regional electricity system". Therefore, the EGAT Grid System with its extension into Lao PDR,

[11] CDM Executive Board (2006) 28th Meeting Report, Paragraph 14.

can be considered as a "connected international electricity system", and determined as the "project boundary" for the proposed Project.
Since 1971, there have been regular power exchanges and interconnections between Lao PDR and Thailand. Currently there are 9 such interconnecting lines situated along the border of Lao PDR and Thailand for import and export purposes (see, Figure B-2). Historical import and export data for Lao PDR and neighbouring countries including Thailand is also available (see Annex 3).

The Xeset II Project will be connected to the Southern Supply Area of Lao PDR, which forms an integral part and extension of the EGAT Grid System (see Figure B-2). The Southern Supply Area is isolated from all other electricity supply areas in Lao PDR and is connected only to the EGAT Grid System (see Figure B-1). Regular exchanges between Lao PDR and Thailand occur without any transmission constraints and according to the blanket Power Purchase Agreement (PPA) between Electricite Du Laos (EDL) and EGAT, EDL can freely import surplus energy without committing to the quantity or timing of either[12].

The Xeset II power houses will be connected via a 45.5 km long double-circuit 115kV transmission line from the switch yard of Xeset II to Paksong. This will be linked to the Southern Supply Area at Chiengxai (Ban Jianjxay) Substation which is presently supplied by Xeset 1 and the Selabam hydro power plant. The linkage will increase reliability and guaranteed electricity supply to the southern Lao and the EGAT Grid System in Thailand. A 3.5km long 115kV transmission line will link the switch yards between Xeset II and Xeset 1. The Chiengxai Substation will be connected to Bangyo Substation which is in turn connected to the EGAT Grid[13] at Ubon Ratchathani, Thailand (See Figure B-2). An electricity exchange agreement has been signed between EDL and EGAT for the Xeset II Project.

Based on the current electricity exchange agreements between Lao PDR and Thailand, the ACM0002 Methodology and the CDM EB meeting clarifications, the spatial extent of the Project boundary is the Project site, Southern Supply Area and the EGAT Grid System (GS) with its extension into Lao PDR.

[12] Power System Development Plan for Lao PDR Final Report, Volume A : Main Report, August 2004, prepared by Maunsell Limited in association with Lahmeyer GmbH p 30

[13] Power Development Plan in Lao PDR 2005-2013

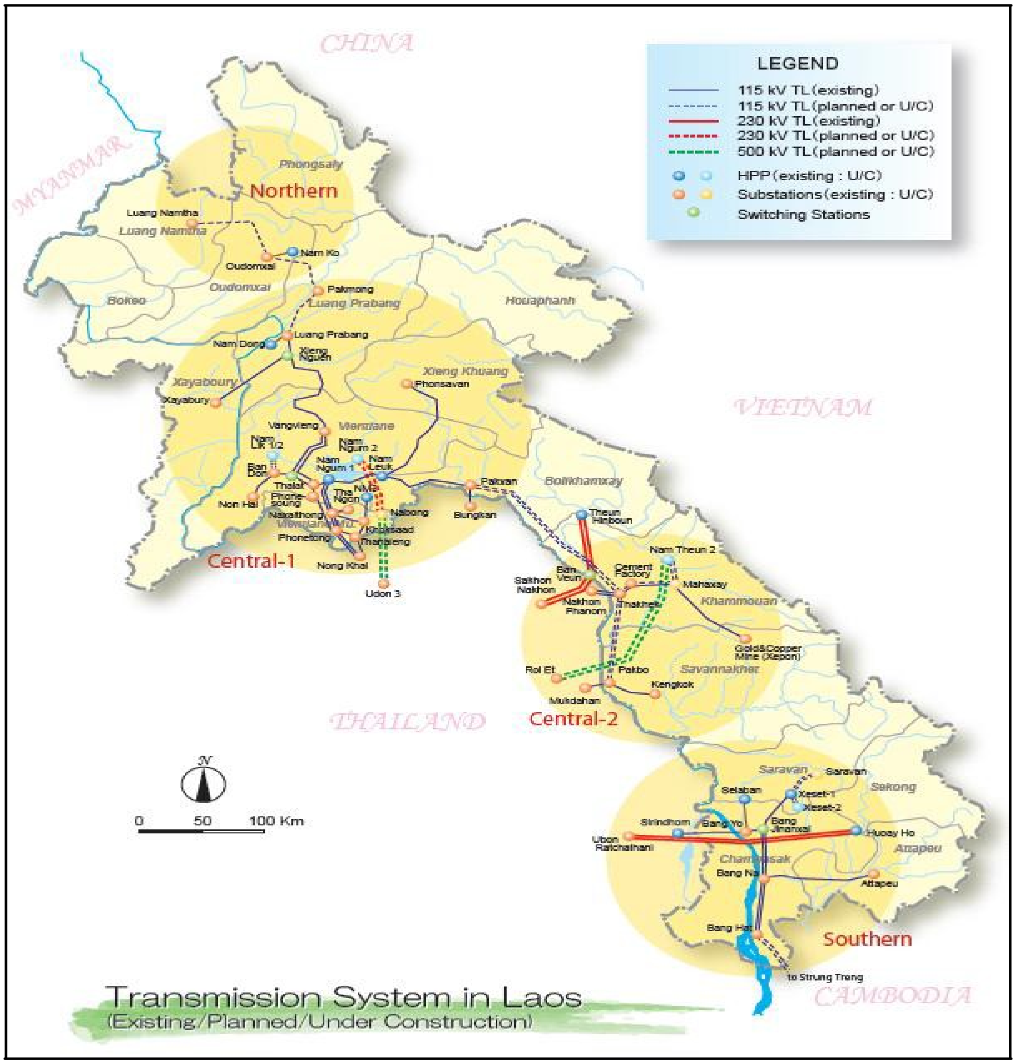

Figure B-1: ***Lao PDR - Transmission System in Laos***

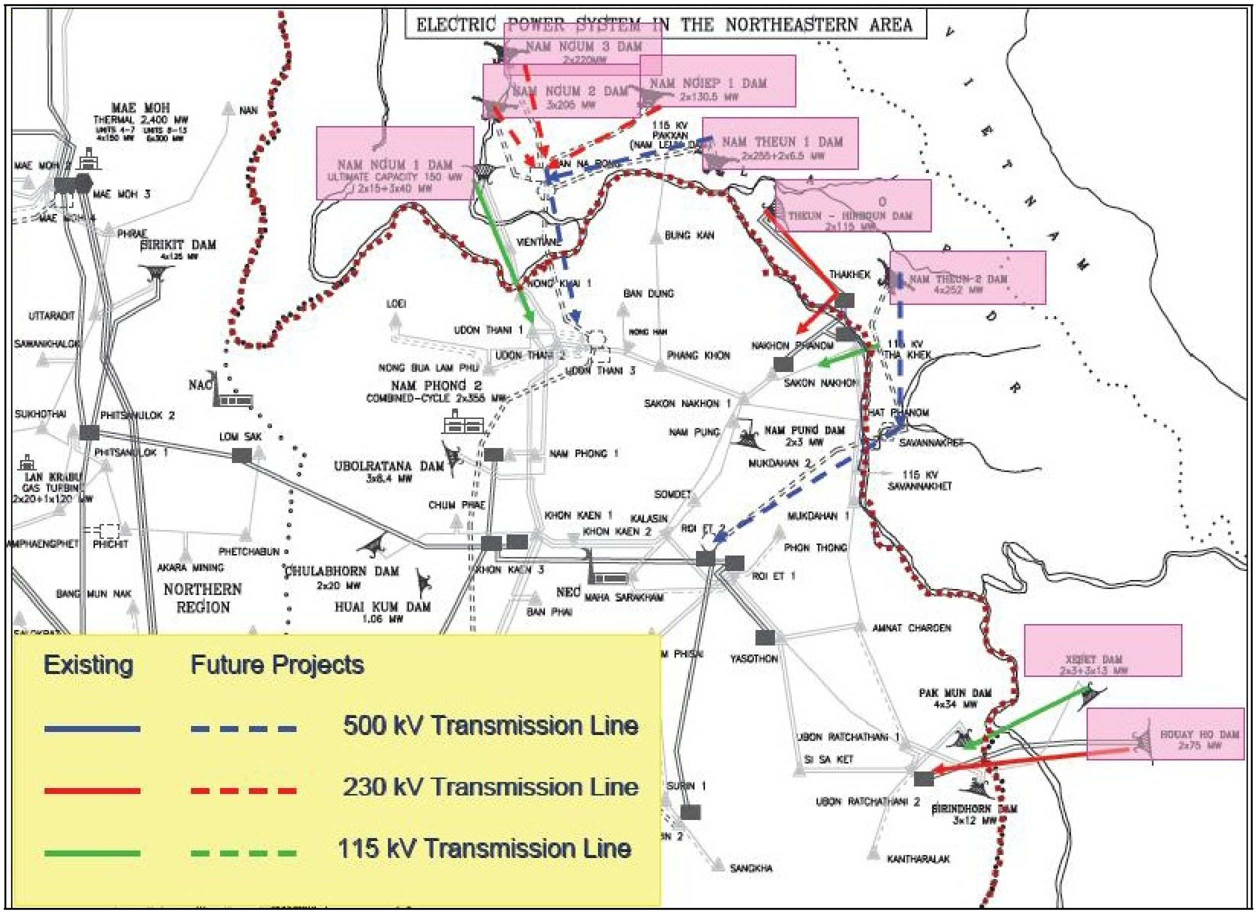

Figure B-2:***Lao PDR - Thailand interconnections***

Source: Thailand Power Development Plan 2007 - 2021[14]

The flow diagram of the Project boundary is shown in figure B-3 below.

[14] Electricity Generating Authority of Thailand (2008), Thailand Power Development Plan 2007 – 2021, revision 1, System Planning Division,

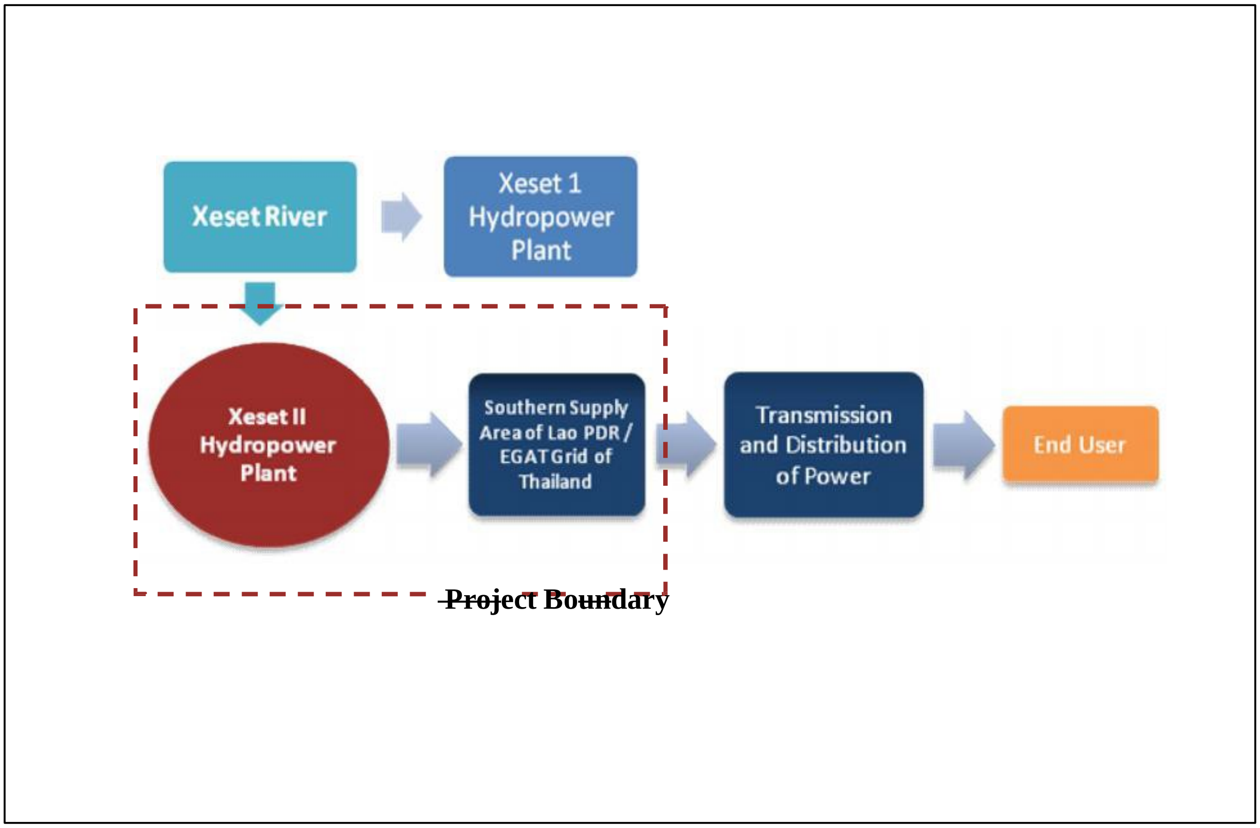

Figure B-3: Diagram of the Project Boundary

The sources and gases included in the project boundary are described below:

	Source	Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO_2	Yes	Main emission source.
		CH_4	No	Minor emission source.
		N_2O	No	Minor emission source.
Project activity	For hydro power plants, emissions of CH_4 from the reservoir.	CO_2	No	Minor emission source.
		CH_4	No	The power density is above 10W/m², therefore according to AM0002, CH_4 emissions are zero.
		N_2O	No	Minor emission source.

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

The Project activity is the installation of a new grid-connected renewable power plant. According to the description provided in the approved baseline methodology ACM0002 (version 12.1.0), the baseline scenario is the following:

> Electricity delivered to the grid by the Project that 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 in B.6.

The baseline scenario is determined by analysing the data from the electricity grid to which the Project causes emission reductions. The proposed Project is connected to the Southern Supply Area of Lao PDR, which forms an integral part and an extension of the EGAT Grid System in Thailand. Currently, electricity exchanges between Laos and EGAT Grid occur regularly without any transmission constraints. Therefore, (as justified in Section B.3 above), the emission reductions will occur within the extended regional EGAT Grid System.

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

The additionality of the Project activity is demonstrated using the "*Tool for the Demonstration and Assessment of Additionality*" (Version 5.2) as specified by the approved methodology ACM0002. These include 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

Realistic and credible alternatives to the proposed CDM project activity comparable with outputs and services include:
a) The proposed Project itself, but not undertaken as a CDM project activity.
b) Construction of a coal-fired power plant with equivalent installed capacity or annual electricity generation.
c) Construction of a power plant using other renewable energy with equivalent installed capacity or annual electricity generation feeding the grid.
d) Continuation of the current situation, where electricity is supplied by the EGAT Grid / Southern Lao PDR grid and no project activity or other alternatives are undertaken.

Alternative b) construction of a coal-fired power plant with equivalent installed capacity or annual electricity generation.

Lao PDR has four isolated electricity networks. These include the Southern Supply area where the Project is located, as well as the Northern Grid, the Central 1 Grid and the Central 2 Grid (see Section B.3). None of these networks are currently connected to each other. According to the Lao National Power Development Plan[15], four thermal power plants are planned in the northern and central parts of the country but no suitable sites for thermal power plants have been identified in the Southern Supply Area. Therefore alternative b) is in compliance with the Lao PDR regulations, but is not a realistic and credible alternative for the Project and is eliminated from the baseline scenario.

c) Construction of a power plant using other renewable energy with equivalent installed capacity or annual electricity generation feeding the grid.
Other renewable energy options including biomass energy, wind, solar and geothermal as identified in alternative c) are not mature enough to handle the electricity demands in the Southern Supply Area and would not be able to supply the equivalent amount of electricity as the proposed Project activity[16].
Therefore, c) is not a realistic and credible alternative and is eliminated from the baseline scenario.

Therefore the outcome of Step 1a demonstrates that the identified realistic and credible alternative scenarios to the Project activity are Alternatives a), and d).

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[15] Maunsell. 2004. "Power Systems Development Plan for Lao PDR: Final Report, Volume A: Main Report" and Lao PDR Power Development Plan 2005-2013, part III, pIII-1.
[16] Country Paper Rural Energy Development and Utilisation: http://www.unescap.org/esd/energy/dialogue/community/documents/Country%20paper%20Lao%20PDR.pdf

Sub-step 1b. Enforcement of applicable laws and regulation

In the development of the Lao power sector the government has identified two vital national priorities. The first priority encourages affordable and reliable power supply to both society and industry with community benefits. The other encourages the promotion of both hydropower and coal powered electricity exports (with both resources available abundantly in Lao PDR) in order to earn foreign exchange[17].

a) The proposed Project itself, but not undertaken as a CDM project activity.
The Lao Government encourages and promotes hydropower development through a series of laws[18], regulations and preferential policies. Therefore, alternative a) is in compliance with legal and regulatory requirements, but is not a realistic and credible alternative as, according to the investment analysis presented in section B.5 below, the project is not a financially attractive without CDM.

d) Continuation of the current situation, with no project activity or other alternatives undertaken (continuation of electricity supply from the EGAT Grid / Southern Lao PDR grid).
Alternative d) is in compliance with legal and regulatory requirements. The Southern Lao PDR / EGAT grid is one interconnected grid (as discussed in Section B.3) and long-term PPAs have been signed between EDL and EGAT allowing a regular flow of electricity supply. Therefore alternative d) is a realistic and credible alternative and is considered as the baseline scenario.

Outcome of Step 1b: Based on the above analysis, the proposed Project activity is not the only alternative amongst the ones identified that is in compliance with the existing legal and regulatory requirements in Lao PDR.

Step 2. Investment Analysis

The purpose of investment analysis is to determine whether the proposed Project activity is not: the most economically or financially attractive; or economically or financially feasible, without the revenue from the sale of CERs. To conduct the investment analysis, the following sub-steps have been applied:

Sub-step 2a. Determine appropriate analysis method

The "*Tool for the Demonstration and Assessment of Additionality" (Version 5.2)* recommends three analysis methods, including simple cost analysis (Option I), investment comparison analysis (Option II) and benchmark analysis (Option III).

The proposed hydropower Project generates financial and economic benefits through the sales of electricity other than CDM related income, therefore the simple cost analysis (Option I) cannot be taken. The investment comparison analysis (Option II) is only applicable to projects where the alternatives are

[17] Power System Development Plan for Lao PDR Final Report, Volume A : Main Report, August 2004, Pg: 21
[18] Lao PDR, Ministry of Industry & Handicraft Lao National Committee for Energy: Power Sector Strategy Study. http://www.poweringprogress.org/lao-energy/policies/pss3.htm

similar investment projects. The alternative baseline scenario of the proposed Project is the continuation of electricity supply from the Southern Lao PDR / EGAT Grid System (alternative (d)) which is not considered to be an investment. Therefore, as per the Annex of the Additionality Tool (version 5.2)[19] the benchmark analysis (Option III) is chosen for this Project activity and the Project Financial Internal Rate of Return (FIRR) is used in analysing whether the Project is financially feasible or not.

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

During the financial assessment of the Xeset II Project activity in 2004 and the decision-making process in 2005, a discount rate of 10% was used to evaluate the Project. This is in line with the discount rate of 10% for government projects confirmed by the Government of Lao PDR[20] and reflected in the Power System Development Plan (PSDP) 2004 for Lao PDR[21]. Based on this, the post-tax benchmark (FIRR) of 10%[22] was selected by the Project proponent. A post-tax Project Financial Internal Rate of Return (FIRR) was selected as the appropriate financial indicator for the Project.

In the PDD submitted for Global Stakeholder Consultation, a benchmark range of 8-10% had been selected, due to lack of official and publicly available references at that time. The conservative estimate of 8% was stated only in the GSC PDD by the consultant (in line with what was used in the Chinese power sector). However, this figure was found to be inaccurate and the benchmark of 10% was confirmed by the above mentioned references which were submitted to the DOE and also confirmed by both the Lao Government and the Project proponent.

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

1) Parameters needed for calculation of key financial indicators.

The financial assumptions of the Project are outlined in the 1999 Feasibility Study (undertaken by Norconsult) and were updated in 2004 during the feasibility assessment. These are as follows in Table B-1 below. Due to limited financing options it took six years after the initial feasibility study for financing and approvals to be in place. This delay resulted in altered Project fundamentals such as total expenditure increasing by more than US$ 40 million to US$135 million. This resulted in the Project being not financially viable without the income from CERs (see Table B-2 below).

It must be noted that at the time of the feasibility assessment in 2004 (prior to the investment decision undertaken in 2005) the total energy output of the Project was estimated at 329,000MWh, (309,000 MWh from the Xeset II plant and an additional 20,000 MWh from the Xeset I plant). Therefore this figure is included in the financial parameters.

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[19] Paragraph 15 of the Annex of the Additionality Tool.

[20] Letter of verification from the Department of Energy Promotion and Development, Government of Lao PDR

[21] Power System Development Plan for Lao PDR 2004, Maunsell and Laymeyer (pp 33, 85, 91, 106, 156, 215 of Vol A; Annex 6.3 of Vol B). http://www.poweringprogress.org/index.php?option=com_jotloader&cid=11&Itemid=97 accessed Dec 2009.

[22] Xeset II Benchmark Letter from EDL.

Table B-1: ***Parameters for calculation of key financial indicators.***

Parameter	**Value**	**Reference from the feasibility assessment (Inputs for the Feasibility Study Report)**
Installed capacity	76MW	1999 Feasibility Study, Xeset II Hydropower Development Project Update, February 2004.
Grid connected electricity output[23] **(at the time of financial calculations in 2004 and the decision to go ahead with the Project in 2005)** • **Output from Xeset II**	309,000 MWh	Feasibility Assessment 2004 and Xeset II Hydropower Project Environmental and Social Action Plan 2004
Construction period (Grace period)[24]	4 years	EDL-Norinco Finance Contract 2004.
Operational lifetime	30 years, 0 months	Xeset II Hydropower Project, Technical Document for Approval – guarantee for equipment performance, Norinco, p25.
Depreciation period	30 years	Xeset II Hydropower Development Project Update, February 2004.
Expected tariff (pre-tax) • **Domestic** • **Export** (export share of 13%)[25]	0.045 USD/kWh 0.040 USD/kWh Tariff increase of 1% p.a	EDL Annual Report 2004 (p23). Power Purchase Agreement between EDL and EGAT, EDL Annual Report 2004 (p23). Xeset II Hydropower Development Project Update, February 2004.
Transmission losses[26]	1.8% of grid connected	EDL Loss Reduction Project 2004.

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[23] The electricity output of Xeset II was revised to 279,600 MWh *after* the decision to go ahead with the Project (Final Design Report, November 2005).

[24] EDL-Norinco Finance Contract 2004, p9.

[25] 13% reduction per year based on forcasted growth in domestic demand in the Southern Supply Area, Lao PDR Power Development Plan 2005-2013

Parameter	Value	Reference from the feasibility assessment (Inputs for the Feasibility Study Report)
	output (based on actuals)*	
Distribution losses[27]	16.3% in 2008 and declining by approximately 1% each year.	Xeset II Hydropower Development Project update, February 2004.
Costs without financial charges	US$117,841,733 (total construction cost).	EDL-Norinco Finance Contract 2004.
Financial charges (e.g. IDC, loan service charges)[28] • **Interest During Construction (IDC)** • **Insurance Premium** **Total financial charges**	 US$9,216,581 US$8,444,175 US$17,660,736	 EDL-Norinco Finance Contract 2004, Bill of Quantities, Xeset II Hydropower Development Project update, February 2004.
Total investment (Contract Value)[29]	US$135.5 million (80% as a Credit Loan from China EXIM Bank, 20% financed by EDL).	EDL-Norinco Finance Contract 2004.
Tax[30]	No tax for the capital	EDL-Norinco Finance Contract 2004.

[26] Based on actual transmission line loss in the Southern grid, EDL Loss Reduction Project 2004 (Transmission loss_actuals_ADB & WB 1-12-04.xls). Note: In the PDD provided for GSC, the transmission losses were based on initial estimate of 1.5%. This was later adjusted to 1.8% based on actual transmission losses for the Southern Supply Area recorded by EDL. The evidence has been submitted to the DOE.

[27] Lao PDR PDP 2007 – 2016, Appendix 2-12, Table 2.4.2, Systems Losses for Champassack Province. Note: calculations were based on EDL's internal estimates which were later officially published in the Lao PDR PDP 2007-2016.

[28] EDL-Norinco Finance Contract 2004, see Bill of Quantities (cost breakdown for financial cost), see Interest 13.5.2 p12 (calculation of Interest During Construction), see Xeset II Hydropower Development Project update 2004 for insurance premium.

[29] EDL-Norince Finance Contract 2004, Bill of Quantities.

[30] EDL-Norinco Finance Contract 2004, see Clause 13.1(c) p7 for details on tax exclusions; Lao PDR Tax Law 2005, Article 40 on profit tax.

Parameter	Value	Reference from the feasibility assessment (Inputs for the Feasibility Study Report)
	costs (Contract Value). 35% profit tax during operation	Lao PDR *Tax Law 2005*, Article 40.
O&M and Environment Fund[31]	US$130,060, including US$111,860 for environment monitoring.	2004 IRR calculations, Environmental and Social Impact Assessment 2004.
Salvage value	Calculated at 5% and only considered for the dam. With a dam value of US$ 39,724,954 the salvage value is US$ 1,986,248.	Report of the Revaluation of Generation and Network Fixed Assets conducted for EDL by Meritec, section (j) EDL-Norinco Finance Contract 2004 – Bill of Quantities.
Crediting period	7 x 3 (renewable)	

2) Comparison of IRR and NPV for the proposed Project and the financial benchmark
In accordance with benchmark analysis (Option III), if the financial indicators of the proposed Project, such as the Project IRR[32], are lower than the benchmark, the proposed Project is not considered to be most financially attractive.

Table B-2 shows the Project IRR and NPV of the proposed Project with and without the sale of CERs. Without the sale of CERs the Project IRR is 5.1% (after tax) which is lower than the financial benchmarks used for similar projects in Lao PDR. Taking into account the CDM revenues, the Project IRR would increase to 5.88% (after tax). The NPV of the proposed Project is USD -43.8 million at the discount rate of 10%. Thus the proposed Project is not financially attractive.

[31] Xeset II Environmental and Social Impact Assessment 2004, budget, p167 - 170

[32] For the benchmark analysis, the IRR shall be calculated as Project IRR.

Table B-2: ***Project IRR and NPV of the proposed Project (after tax[33]).***

	Without CERs	**With CERs**
Project FiRR %	5.1	5.88
NPV MUSD	-47.6	-41.6

The CDM Project activity has a less favorable indicator (i.e. lower IRR of 5.1%) than the benchmark applied (post tax FIRR of 10%). Therefore, it can be concluded that the Project activity is not the most economically or financially attractive.

Sub-step 2d. Sensitivity analysis

The sensitivity analysis shall show whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. For the proposed Project, four parameters were selected as sensitive factors:
1) Total investment.
2) Annual Operation and Maintenance (O&M) costs.
3) Expected tariffs – domestic and export (excl. tax).
4) Annual electricity output.

The results of sensitivity analysis (on an after tax basis) are shown in Table B-3 and Figure B-5 below.

Table B-3: Sensitivity analysis of the proposed Project (after- tax).

	-10%	**-8%**	**-5%**	**0%**	**3%**	**5%**	**8%**	**10%**
Total investment	5.88%	5.72%	5.48%	5.10%	4.89%	4.76%	4.56%	4.43%
Annual O&M cost	5.11%	5.11%	5.11%	5.10%	5.10%	5.10%	5.10%	5.10%
Tariff (excl. Tax)	4.93%	4.96%	5.02%	5.10%	5.16%	5.19%	5.25%	5.28%
Electricity Output	4.35%	4.51%	4.74%	5.10%	5.32%	5.46%	5.67%	5.81%

[33] In the Global Stakeholder Consultation version of the PDD, the IRR did not include the tax component. This was later corrected (by adding the company tax) to reflect the true financial circumstances of the project.

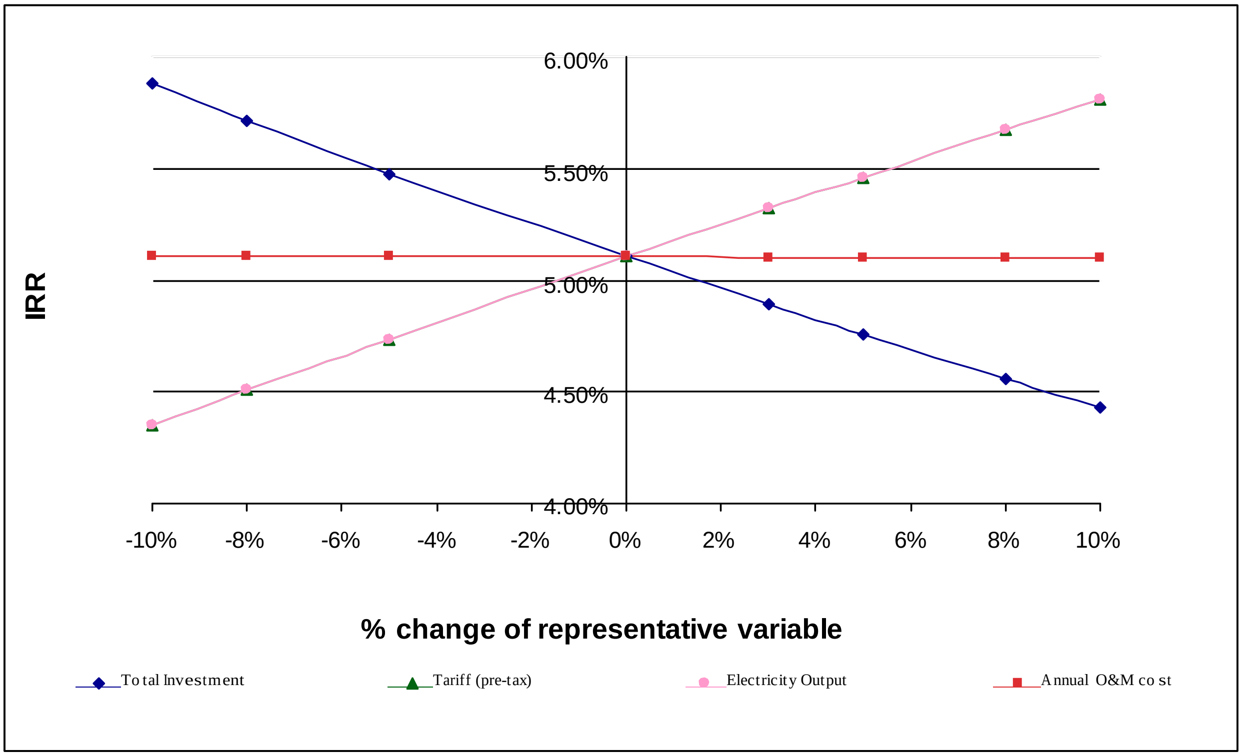

Figure B-5: ***Sensitivity analysis of the proposed Project (after- tax).***

The Project IRR of the proposed Project varies to different degrees in accordance with the fluctuation of the four parameters within the range of negative 10% to positive 10%.

The results show that regardless of whether the four parameters increase or decrease by 10%, the project IRR is still lower than the benchmark of 10% required for similar power projects in Lao PDR. Therefore the proposed project will be financially unattractive within a reasonable range of the four parameters. The project IRR will only reach the benchmark (10%) if the parameters vary by over 10%, but the likelihood of this occurring is very low for the reasons outlined below.

For the project IRR to reach the benchmark, the tariff would need to increase by 275.3%. The government of Lao PDR has authorized according to its official notice no. 845/PMO, dated 06/06/2005, the use of the amended electricity tariffs, with a 1% increase of the average of tariffs annually. Therefore it is unlikely that the tariff will increase to such an extent.

For the project IRR to equal the benchmark the O&M costs need to reduce by 7000%. The results of the sensitivity analysis show that this parameter is an insensitive factor, therefore it almost impossible that the project IRR will reach the benchmark.

- For the Project IRR to equal the benchmark the total investment needs to decrease by 67.0%. When financing was secured for the Project in 2004, the total investment cost had increased by over US$ 40 million than what was initially estimated in the feasibility study (construction began in 2005)[34] due to the impacts of the Asian Economic Crises and altered Project fundamentals (as detailed in the Barriers Analysis). Therefore the likelihood of the investment costs decreasing is very low.

When the project IRR equals the benchmark, the annual electricity output would need to increase by 67.4%. Calculations for the annual electricity output are sourced from the hydrological and plant optimization studies undertaken for the Project in the Final Design Report and the Feasibility Study, using hydrological records from 198435. The Report was reviewed by external consultants and approved. Therefore it is unlikely that the electricity output will change to such an extent.

These results show that even under favourable circumstances the Project IRR is still lower than the benchmark IRR required for power project investments in Lao PDR. The Project, therefore, cannot be considered financially attractive and potentially may not be feasible in the long run.

Step 3. Barriers Analysis

Without CDM registration, the proposed Project faces a number of barriers that would prevent the successful implementation of the Project and significantly impact on the economics and sustainability of the Project.
At the same time, these barriers are much less likely to prevent the implementation of alternative projects.

Sub-step 3a: Identify barriers that would prevent the implementation of the proposed CDM project activity:

1. Financial and Investment Constraints

The total exploitable hydropower potential of Lao PDR is around 23,000 MW, yet only about 623 MW has been developed so far[36]. This is largely due to financial and investment constraints faced by the renewable energy sector in Lao PDR. These are outlined below.

Poor investment climate - Lao PDR is a Least Developed Country (LDC) and the second poorest country in East Asia (after Cambodia). The government has become dependent on foreign aid, and a generally poor investment climate and limited infrastructure make it difficult to attract foreign direct investment. The main sectors which are able to attract foreign investment have been the mining and hydropower sectors, yet these sectors have experienced difficulty in attracting investment, especially in the wake of Asian Economic Crisis of 1997. During the crisis, FDI declined dramatically and most foreign investors

[34] 1999 Feasibility Study, Section 13.3.4 p101 and 2004 EDL-Norinco financial contract, Bill of Quantities

[35] 1999 Feasibility Study, Section 3.4, p24

[36] 2006 'Promotion of renewable energy, energy efficiency and greenhouse gas abatement (PREGA) Lao PDR, country and policy report' p36 - http://www.greengrowth.org/download/green-business pub/Greening_of_the_Business/Governments/Lao_People_s_Democratic_Country_Report.pdf

withdrew from Lao PDR. Foreign direct investment commitments to Lao PDR fell by 91 percent in 1997, and actual flows declined by 41 percent[37].

The poor investment climate affected the project proponent's ability to secure funding for the Project which initially began in 1999. The initial feasibility study (in 1999) conducted by Norwegian consulting company, Norconsult, concluded that the Project was considered to be financially viable at that time using a benchmark of 12%[38]. However, the project did not go ahead due to country investment barriers that prevented the project proponent from obtaining financing. Changes in power tariffs due to the impacts of the Asian economic crisis in the late 1990s in the region lead to the further lowering of electricity sales prices and resulted in a high cost per unit energy produced. This and other increases in project development costs contributed to the lowering of the IRR and the delay in securing any further investment for the Project. It took 6 years to secure the financing arrangements and when the financial assessment was updated in 2004, the Project's viability was threatened with an IRR of 5.1% (as described in the Investment Analysis and evidence provided to the DOE).

Limited financing options **-** Lao PDR relies heavily on foreign aid for financing infrastructure and power projects. In the past EDL-owned projects have been financed by multilateral and bilateral agencies on concessional terms. In the early days of the sector, demand for electricity was low and capital needs were manageable. With a rapid growth in demand, the availability of concessional funds and grants could not keep up the with the increasing capital requirements of the sector. Furthermore, policy shifts of development agencies towards social and governance objectives have lead to a decline in support for power generation investments[39]. This has also limited the financing options available to the project proponent.

Lao PDR wants to reduce its dependence on foreign aid, especially in the energy sector, yet faces barriers in attracting financing. Power generation projects involve high capital costs and returns over long time. Local banks operate on a shorter timeframe and do not grant sufficient long term credits, especially for power generation projects. Long-term financing from international sources is required, yet the country risk limits the ability to attract long-term financing.

Schedule **–** Due to the limited financing options available to the project proponent it took six years after the initial feasibility study for financing and approvals to be in place with Lao PDR National Assembly Approval for the Project on 7/06/2005. This delay exposed the Project to higher risks due to extended timeframes and altered project fundamentals. Changes in power tariffs after the economic crisis of 1997 lead to lower electricity sales prices and resulted in a high cost per unit energy produced. Project expenditure increased by more than $40 million to US $135 million and the Project IRR decreased to 5.1% which is below the applicable benchmark. If the IRR is below the benchmark, then the Project's financial viability is threatened. Securing CDM eligibility would help remove the investment and financial constraints, and improve the financial viability of the Project.

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[37] Okomjo-Iweala, N., Kwakwa, V., Beckwith, A. & Ahmed, Z. (1999), "Impact of Asia's Financial Crisis on Cambodia and the Lao PDR", Finance & Development, September, P48 – 51.

[38] Xeset 2 199 Feasibility Study.

[39] Power System Development Plan 2004 (Maunsell and Layahmer), Vol A p83, p125

2. Technology and Skill Barriers

Lao PDR is a least developed country (LDC) and access to technology and required skills in the construction and operation of a hydropower plant is a potential barrier within the country, particularly in rural areas such as Saravan Province.

Outcome of Step 3a: Xeset II Hydropower Project faces several barriers to its development. The risks outlined above have imposed barriers impacting the financial viability of the Project that without registration as a CDM project activity would seriously threaten its long-term viability. This would discourage the implementation of similar projects planned by the project proponent, promoting the supply of electricity from non renewable energy projects in the region. As of June 2009, only one project in Lao PDR has received CDM registration and no other project is listed in the CDM pipeline.

Sub-step 3 b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):
The barriers identified in sub-step 3a do not prevent the implementation of alternative projects. The most realist and credible alternative is to import power from the EGAT Grid in Thailand.

Lower risks - There is less risk involved with importing power from the EGAT Grid as this will not be subject to the perceived risks involved with investing in the renewable energy sector and in hydropower in particular.

Lower capital costs - Importing power from the EGAT Grid will involve lower capital costs than the development of Xeset II Hydropower Project.

Technology and skills barriers – Power from the EGAT Grid is supported by a more strongly supported technology and skills base in Thailand.

Step 4. Common practice analysis

Sub-step 4a. Analyse other activities similar to the proposed project activity:

According to the "*Tool for the demonstration and assessment of additionality" (Version 5.2)*, "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 framework, investment climate, access to technology, access to financing, etc".

The power sector of Lao PDR is divided into four principal unconnected supply areas, one of these being the Southern Supply Area which supplies the Champassack, Saravan and Attapue Provinces of Southern Lao PDR (see section B.3). The common practice analysis will be limited to this region only.

At present there are two existing hydropower projects in operation in the Southern Supply Area that are comparable with the proposed Project[40]. These are also connected to the EGAT grid (see Table B-4 below).

Table B-4: ***Similar project activities in the region.***

Project Name	Location	Installed Capacity (MW)	Output Generation (MWh/ year)	Year Commissioned	Project Owner
Xeset 1	Saravan	45	180,000	1990	Electricite du Laos
Houay Ho	Attapue	150	617,000	1999	Suez Energy (Belgium)

Source: Department of Energy Promotion & Development, Ministry of Energy and Mine (http://www.poweringprogress.org/index.php?option=com_jotloader&cid=10&Itemid=91

Sub-step 4b. Discuss any similar options that are occurring:

There are essential distinctions between the proposed Project and the last hydropower plant prior to the proposed Project listed in Table B-4 above.

The Xeset 1 project (45 MW) is a state owned project co-financed by the ADB, UNDP, Sweden (SIDA) and Norway, which was originally appraised in 1987 and commissioned in 1991[41] under a different investment climate prior to the Asian Economic Crisis in 1997. In that period of power sector development, electricity demand was low and capital needs were manageable, therefore state owned projects such as Xeset 1 had access to financing from multi-lateral and bi-lateral agencies. However with the rapid growth in power demand in the last decade, the availability of concessional funds and grants were not able to keep up the increasing capital requirements of the sector. These factors combined with a policy shift in development agencies towards social and governance objectives lead to an abrupt decline in support for power generation investments[42]. Hence the investment climates of the two projects are not comparable.

The Houay Ho project is one of the first IPP power generation projects in Lao PDR under a different investment climate prior to the Asian Economic Crisis in 1997[43]. Although the project was commissioned in 1999, the original tariff agreements were derived in the mid-1990s, before the economic crisis. Much has changed since then, including a realignment of Asian currencies and changes in the cost of power

[40] Source: Department of Energy Promotion & Development, Ministry of Energy and Mine (http://www.poweringprogress.org/index.php?option=com_jotloader&cid=10&Itemid=91

[41] *ADB. "Report and recommendation of the President to the Board of Directors on a proposed supplementary loan to the LAO PDR for the Xeset Hydropower Project"*, 19 November 1990 (RRP:Lao16161).

[42] Power System Development Plan 2004 (Maunsell and Layahmer) p22.

[43] Power System Development Plan 2004 (Maunsell and Layahmer) p197, p125, p127.

generation. Between 1999 and 2005 financial investment in hydropower in Lao PDR was severely constrained. These factors combined with a policy shift in development agencies towards social and governance objectives lead to an abrupt decline in support for power generation investments[44].

From the analysis above, there are essential distinctions between the proposed Project and other hydropower projects in the region. Therefore, the proposed Project activity is not considered as common practice for the region and is additional.

Consideration of CDM before construction of the proposed Project

The initial feasibility study for the Project was conducted in 1999, however the Project was put on hold until 2004 due to lack of financing (see Barrier Analysis) The Project began construction in November 2005 and was commissioned on 9th September 2009. CDM benefit and greenhouse gas emission reductions were considered during the feasibility and environmental assessment stage of the Project. Carbon financing incentives prior to the Project construction played a key role in the decision to go ahead with the Project. The consideration of CDM benefit is evidenced by the overview of key events given in Table B-5.

The Government of Lao PDR ratified the Kyoto Protocol on the 6 February 2003 and established the Lao DNA in 2004. As a State Owned Enterprise, the project proponent, EDL, was engaged early (since March 2004) to consider the application of CDM and its benefits for its projects in the pipeline[45]. EDL has been active in promoting CDM and renewable energy projects in Lao PDR. In particular, the hydropower sector was one of the sectors prioritised for the development of CDM projects.

In June 2004, an Environmental and Social Impact Assessment (ESIA) was conducted for the Xeset II Hydropower Project which identified the benefits of emission reductions as a result of the fossil fuel replacement in the connecting grid[46]. Continuing action was undertaken to secure CDM status in parallel to Project implementation (from 2004 – 2006), and a dialogue was established with the World Bank to receive carbon finance (Prototype Carbon Finance) and develop the Project as a CDM project. The investment decision along with CDM benefits was considered during this time with the development of the PIN in October 2005 followed by a formal agreement between the Government of Lao PDR (previous Ministry of Industry and Handicrafts) and the World Bank to collaborate on the development of the Project (see Table below).

In mid 2006 a site visit was conducted by the World Bank[47], however in early 2007, the project proponent was required to engage a different CDM consultant, as the previous consultant was unable to continue with the service[48]. The lack of CDM expertise at that time, both internally and in Lao PDR contributed to

[44] Power System Development Plan 2004 (Maunsell and Layahmer) p22, p83.

[45] *Promoting of renewable Energy and Energy Efficiency and Greenhouse Gas Abatement (PREGA),* Lao PDR, Country and Policy Report", UN ESCAP, Green Growth, May 2006.

[46] Earth Systems Lao. Xeset II Hydropower Project Lao PDR - Environmental and Social Impact Assessment, Main Report, June 2004, p156-157

[47] Documentation and name of first consultant provided to DOE

[48] CDM proposal and contract provided to the DOE

this delay in engaging another consultant. The regulatory climate in Lao PDR for CDM development process was not yet fully developed and therefore clear direction from supporting agencies in Lao PDR hindered the project proponent from early CDM registration. Furthermore, as a trans-national electricity Project exporting to Thailand as well as Southern Lao PDR, the Xeset II Project is a unique CDM Project and this also lead to further delays in the CDM registration process. However the Project participants through the help of the new consultant took continuing action to develop the Project as a CDM project. Throughout 2007, the PDD was developed and the Project was marketed to international carbon credit buyers. In February 2008, the project proponent signed an Emission Reduction Purchase Agreement (ERPA), for the sale of CERs from the Xeset II Hydropower Project[49]and throughout 2008-2009 there was ongoing liaison with the Lao and Thai DNAs during the approval process[50].

Table B-5: ***Overview of key events in the development of the Project.***

Date	Key Event	Evidence
1999	Initial Feasibility Study by Norconsult (Project put on hold until 2004 due to lack of financing)	Feasibility Study
February - April 2004	Update of initial feasibility assessment	Xeset II Hydropower Development Project update, February 2004.
June 2004	ESIA conducted for Xeset II.	ESIA and Compliance Certificate
2004 - 2006	Dialogue established with the first consultant to assist in carbon financing and CDM.	Provided in this table below
07 June 2005	Project approval from National Assembly.	Certificate
11 October 2005	Decision to go ahead with CDM development	PIN
17 October 2005	Purchase of Project equipment (considered as start date of CDM Project activity)	Xeset II Supply Contract
13 November 2005	Start of construction.	Evidence available

[49] CDM Emissions Reduction Purchase Agreement, Xeset II (76MW) and Xeset 1 (Additional 20GWh generation) Hydropower Project by and between Electricite Du Laos (EDL) (Project Entity) and Vitol S.A (Buyer), 11th February 2008.

[50] Evidence of correspondence given to the DOE

Date	Key Event	Evidence
29 December 2005	Formal agreement with the World Bank and the Lao Government to collaborate on the CDM development of Xeset II	Letter available
18 – 23 June 2006	World Bank mission and site investigation for the further evaluation and planning of the CDM development of Xeset II.	Aide Memoire of the Mission
1 February 2007	Formal engagement of a second consultant to assist with the CDM process	CDM Contract
2007 - 2009	PDD development and marketing	Correspondence with buyer and project proponent
11 February 2008	ERPA signed with buyer.	ERPA
27 November 2008	Lao Designated National Authority (DNA) site visit and consultation	Consultation records, correspondence
December 2008 – September 2009	Ongoing correspondence with the Thai DNA	Correspondence
1st July 2009	Lao DNA Approval received	LoA
9 September 2009	Commercial operation date.	Evidence available
17th September 2009	Thai DNA Letter of Non Objection received	Letter available
25th November 2010	Swiss Letter of Approval received.	Letter available

The above events clearly demonstrate that the project proponent was aware of the potential benefits of CDM financing before the start of the Project activity and that it played a crucial role in overcoming the barriers towards implementation of the proposed activity.

Impact of CDM registration

To summarise, without the CDM revenues, the Project activity would not be financially feasible and this would hinder the project proponent's ability to deliver a sound and sustainable project. The income from the CERs will be important in helping to deliver the environmental and social action plan that has been prepared for the Project which will be of benefit to the communities surrounding the Project.

CDM registration will result in additional revenue for the Project, removing the financial barriers towards its realisation and improving the Project's economic viability and sustainability. The income through CDM will raise the Project IRR from 5.1% to 5.88%. Additionally, the project proponent has committed to providing a portion of the CDM revenue to sustainability initiatives associated with the Project which would benefit the surrounding community.

Furthermore, as the first CDM project in the renewable energy sector in Lao PDR, the registration of the Xeset II Project will provide an incentive for the development of similar marginal run of river hydropower projects planned by EDL. In the last 30 years, less than 2% of the country's hydropower potential has been developed[51]. The registration of this Project as a CDM project will encourage the hydropower sector in Lao PDR to effectively compete with other economically viable options such as fossil fuel power projects, contributing to further emission reductions. This will assist the Government of Lao PDR with its objective of moving out of Least Developing Country (LDC) status by 2020. Thus, the proposed Project is additional to the baseline scenario.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Emission reductions from the proposed Project can be calculated based on the version 12.1.0 of ACM0002 (Consolidated methodology for grid-connected electricity generation from renewable sources) and version 02.1.0 of the tool to calculate the emission factor for an electricity system.

The "tool to calculate the emission factor for an electricity system" defines project and connected electricity systems as the following:

> A **project electricity system** is defined by the special extent of the power plants (includes the project site and all power plants connected physically to the electricity system) that can be dispatched without significant transmission constraints.

[51] http://www.poweringprogress.org/index.php?option=com_content&view=article&id=90&Itemid=125

A **connected electricity system**, e.g. national or international, 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.

In terms of applicability, the Project produces renewable energy from hydropower electricity. The Project activity will result in the plant having a grid connection and the renewable electricity supplied from the Project activity to the grid is expected to replace existing and planned projects (the majority of which are fossil fuel based) generating from the regional grid that covers the Southern Supply area and the EGAT Grid System. The Project entity will only claim emission reductions for the energy generated from Xeset II hydropower plant (in line with the ACM0002 methodology requirements) and not for the increased electricity output at the Xeset 1 power plant as a result of the Project.

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 calculated as follows:

$$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y} \quad \textbf{(6)}$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year y (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

1) Calculation of net electricity generation, $EG_{PJ,y}$

(a) Greenfield renewable energy power plants

The project activity is the installation of a new grid-connected renewable power plant at a site where no renewable power plant was operated prior to the implementation of the project activity, therefore:

$$EG_{PJ,y} = EG_{facility,y} \quad \textbf{(7)}$$

Where:

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

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

2) Calculation of Combined margin CO_2 emission factor, $EF_{grid,CM,y}$

According to the "tool to calculate the emission factor for an electricity system"(version 02.1.0), first the Operating Margin (OM) and Build Margin (BM) emission factors (ex-ante) are calculated for the grid. Thereafter, the baseline emission factor (EFy) is calculated as the weighted average of the OM emissions factor and the BM emissions factor. The final step is the estimation of the emission reductions from Project activity, which is the electricity supplied to grid multiplied by the baseline emission factor.

Table B-6: ***Parameters used in the combined margin CO_2emission factor calculations***

Parameter	SI unit	Description
$EF_{grid,CM,y}$	tCO_2/MWh	Combined margin CO_2 emission factor for the project electricity system in year *y*
$EF_{grid,BM,y}$	tCO_2/MWh	Build margin CO_2 emission factor for the project electricity system in year *y*
$EF_{grid,OM,y}$	tCO_2/MWh	Operating margin CO_2 emission factor for the project electricity system in year *y*

The following seven steps are applied to calculate the emission factor for an electricity system:
STEP 1. Identify the relevant electricity systems.
STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional).
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. Identify the group of power units to be included in the build margin (BM).
STEP 6. Calculate the build margin emission factor.
STEP 7. Calculate the combined margin (CM) emissions factor.

The data used to calculate the grid emissions factor comes from reliable and publicly accessible statistics e.g EGAT, the Thai Energy Planning Policy Office (EPPO), Electricité du Laos (EDL) and the Department of Alternative Energy Development and Efficiency (DEDE) websites.

Step1: Identify the relevant electricity system.

The Project boundary is the Project site, the Southern Supply Area and EGAT Grid System (GS) with its extension into Lao PDR. The CDM Executive Board (EB) in its 28th meeting in December 2006[52], clarified that the word "regional", in context of "regional electricity system" used in ACM0002, can also be interpreted as extending across international boundaries. The Board further clarified that trans-national electricity systems are eligible under ACM0002 and that the grid emission factor in this context shall be estimated for the "regional electricity system". Therefore, the EGAT Grid System with its extension into Lao PDR, can be considered as a "connected international electricity system", and determined as the "project boundary" for the proposed Project.

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

Off-grid power plants were not included in the project electricity system. The baseline emission factor was calculated only for the grid connected power plants (Option I).

Step3: Select a method to determine the operating margin (OM).

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:
(a) Simple OM; or
(b) Simple adjusted OM; or
(c) Dispatch data analysis OM; or
(d) Average OM.
To calculate $EF_{grid,OM,y}$ using Simple adjusted OM (Option B), would require the annual load duration curve of the grid. However, the relevant information is not publicly available and is difficult to obtain. Therefore, *Option B* is not applicable.

Dispatch data analysis (Option C) requires the detailed operation and dispatch data of power plants in the grid. This data is also not publicly available for the EGAT Grid. Therefore, *Option c* is not applicable.

Average OM (Option D), 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 EGAT Grid System and therefore *Option D* is not applicable.

The simple OM (Option A) 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 normals for hydroelectricity production. Over 60% of the total grid generation (including total grid generation of EGAT and Lao PDR Grid) is produced from natural gas which is not a low-cost must run power resource.

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[52] CDM Executive Board (2006) 28th Meeting Report, Paragraph 14.

Therefore, the low-cost / must run resources constitute less than 40% of the total grid generation and the simple OM (Option A) can be used.

Table B-7: ***Natural gas power output as a percentage of total grid generation***

	2003	**2004**	**2005**	**2006**	**2007**
Unit	(MWh)	(MWh)	(MWh)	(MWh)	(MWh)
Total national grid generation in Thailand [1]	116,983,000	125,727,000	132,197,000	138,742,000	143,378,000
Total grid generation in Southern Supply Area in Lao PDR (hydro power projects - Xeset 1, Selabam and Houay Ho)[2]	604,342	533,920	586,798	670,007	648,386
Combined Total Grid Generation	117,587,342	126,260,920	132,783,798	139,412,007	144,026,386
Natural Gas[3]	76,332,000	80,489,000	85,703,000	86,339,000	88,166,000
% of Natural Gas Generation	64.92%	63.75%	64.54%	61.93%	61.22%
% of low cost / must run	**35.08%**	**36.25%**	**35.46%**	**38.07%**	**38.78%**
Sources: [1] Electrical Power in Thailand 2007, Table 17, Page 21, Thailand DEDE, 2007 [2] Statistic Year Book, 2009. Page 8. EDL, Statistics Planning Office, (2009). [3] Electrical Power in Thailand 2007, Table 16, Page 20, Thailand DEDE, 2007					

The $EF_{grid,OM\ simple,y}$ can be calculated using either of the two following data vintages for years(s) y:

- (ex-ante) the full generation-weighted average for the most recent 3 years for which data are available at the time of PDD submission; or
- the year in which project generation occurs, if $EF_{grid,OM\ simple,y}$ is updated based on ex-post monitoring.

Here ex-ante vintage is chosen based on the most recently available data (last 3 years) at the time of PDD submission, and $EF_{grid,OM\ simple,y}$ is fixed 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 the availability of data, the Simple OM can be calculated using Option B based on the data on the total net electricity generation of all power plants serving the systems and the fuel types and total fuel consumption of the project electricity systems.

Option B: Calculation based on total fuel consumption and electricity generation of the system

The formula of $EF_{grid,OM\ simple,y}$ calculation is:

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

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,y}$	=	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EG_y	=	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year *y* (MWh)
i	=	All fossil fuel types combusted in power sources in the project electricity system in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3

For this approach (simple OM) to calculate the operating margin, the subscript *m* refers to the power plants/units delivering electricity to the grid, not including low-cost/must-run power plants/units, and including electricity imports[5] to the grid. Electricity imports should be treated as one power plant *m*.

The calculations have drawn upon publicly available information such as the "Estimation of emission factor for an electricity system in Thailand 2007"[53].

The Simple OM Emission Factor ($EF_{grid,OM\ simple,y}$) of the proposed Project is calculated on the basis of the fuel consumption data for electricity generation of the EGAT Grid System, excluding those of low-operating cost and must-run power plants, such as biomass, hydropower and nuclear etc.
Based on these data, the Simple OM Emission Factor ($EF_{grid,OM\ simple,y}$) of the EGAT Grid System is calculated as 0.5716 tCO_2e / MWh (see Annex 3 for details).

Step 5: Identify the group of power units to be included in the build margin (BM).

The BM emissions factor ($EF_{grid,BM,y}$) 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 sample group of power units *m* used to calculate the BM consists of either:

(a) The set of five power units that have been built most recently, or

[53] Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.

(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options the sample group that comprises the larger annual generation. Power plant capacity additions registered as CDM project activities should be excluded from the sample group *m*. If 20% falls on part capacity of a plant, that plant is included in the calculation.

Table B-8 : *Selection of Sample group for Build Margin*

	Energy (MWh)
Total Generation (MWh) in 2007	144,026,386
20% of the total generation	28,805,277
Five power plants built most recently	8,881,929

As shown in Table B-7, in 2007, the total generation of the grid under consideration (EGAT grid system with extension to Lao PDR) amounted to 144,026,386 MWh, of which 20% is equal to 28,955,274 MWh. The five most recent plants only account for less than this amount and therefore the sample to determine the BM is selected on the basis of the "power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently".

The calculation of the BM requires us to undertake a generation weighted average of the emissions of the individual plants (as shown in Annex 3). We have chosen to calculate the BM using Option 1 (ex-ante) therefore the BM emission factor will be held constant over the crediting period chosen.

Step 6: Calculate the build margin emission factor.

According to the "tool to calculate the emission factor for an electricity system", $EF_{grid, BM,y}$ is determined by the formula as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{(13)}$$

Where:

$EF_{grid,BM,y}$	= Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	= Power units included in the build margin
y	= Most recent historical year for which power generation data is available

The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) should be determined as per the guidance in Step 4 (a) for the simple OM, using options A1, A2 or A3, using for *y* the most recent historical year for which power generation data is available, and using for *m* the power units included in the build margin.

Option A1 was used to calculate CO_2 emission factor for each power unit *m* ($EF_{EL,m,y}$). The formula is shown below:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}} \qquad \textbf{(2)}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	=	Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$	=	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	=	All power units serving the grid in year *y* except low-cost/must-run power units
i	=	All fossil fuel types combusted in power unit *m* in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3

The calculations have drawn upon publicly available information such as the “estimation of emission factor for an electricity system in Thailand 2007”[54] and the Electricité du Laos (EDL) Annual Report 2007.

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.

The Build Margin emission factor *($EF_{grid,BM,y}$)* of the EGAT Grid System is calculated as 0.4381 tCO_2e / MWh (see Annex 3 for details).

Step 7: Calculate the combined margin (CM) emissions factor.

The Combined Margin emission factor ($EF_{grid,CM,y}$) is calculated using the following equation:

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[54] Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.

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

Where:

$EF_{grid,BM,y}$	= Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	= Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	= Weighting of operating margin emissions factor (%)
w_{BM}	= Weighting of build margin emissions factor (%)

w_{OM} = 0.5 by default

w_{BM} = 0.5 by default

The weights applied to the OM and BM are fixed at 0.5 for hydropower projects, therefore in order to calculate the CM we apply these to the Simple OM and BM as calculated above. The calculations have drawn upon publicly available information such as the "estimation of emission factor for an electricity system in Thailand 2007"[55].

The Combined Margin emission factor *($EF_{grid, CM,y}$)* is 0.5048 tCO_2 / MWh (see Annex 3 for details).

Calculation of Baseline Emissions, BE_y

$$BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y} \qquad (6)$$

Where:

BE_y	= Baseline emissions in year *y* (tCO_2/yr)
$EG_{PJ,y}$	= Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	= Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system" (tCO_2/MWh)

The Baseline emissions are calculated as **155,983** tCO_2/ yr (see Annex 3 for details).

3) Calculation of project emissions

According to ACM0002 (version 12.1.0) the power density of the Project activity (PD) is calculated as:

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

[55] Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.

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)

The installed capacity of the Project is 76,000,000 W and the area of the new reservoir at Full Supply Level is 180 000 m^2. Thus the power density of the Project is 422.2 W/m^2 which is greater than $10W/m^2$. Therefore, according to ACM0002, the project emissions (*PE*y) are 0 t CO_2e/yr.

Calculation of emission reductions

Emission reductions are calculated according to the following formula:

$$ER_y = BE_y - PE_y$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
PE_y	=	Project emissions in year *y* (t CO_2e/yr)

The Project does not involve project emissions or leakage as explained in section B.6.3 below. Therefore, project emission reductions are equal to baseline emissions. Using the results of the preceding sections, we can calculate the emission reductions.

The emissions reductions are calculated as **155,983** tCO_2/ yr (see Annex 3 for details).

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

Data and parameters required for assessment and demonstration of additionality are available when validation is undertaken. They are not monitored throughout the crediting period but are determined only once at the start of the project and thus remain fixed throughout the crediting period.

Data / Parameter:	$EF_{grid,CM,y}$
Data unit:	t CO_2 / MWh.
Description:	CO_2 emission factor for the grid electricity during the year *y*.

Source of data used:	Used the latest approved version of ACM0002 to calculate the grid emission factor and latest version of the tool to calculate the emission factor for an electricity system Also calculations are based on publicly available information such as: "The estimation of emission factor for an electricity system in Thailand 2007"[56] to calculate emission factor for the Thailand.
Value applied:	0.5048
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data used in calculating this grid electricity emission factor is exhibited in *Annex 3* of this PDD.
Any comment:	The project participant chooses to calculate this emission factor once at the start of the project activity, consistent with guidance in ACM0002.

Data / Parameter:	$NCV_{i,y}$
Data unit:	TJ/volume or TJ/mass.
Description:	Net calorific value (energy content) of fuel i.
	EGAT Annual Reports (2003~2006) and EPPO website (2000~2006).
Value applied:	See Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied :	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Any comment:	

Data / Parameter:	$EF_{CO2,i,y}$
Data unit:	tC/TJ
Description:	CO_2 emission factor per unit of energy of the fuel i.
	IPCC Good Practice Guidance.
Value applied:	See Annex 3.
Justification of the	2006 IPCC Guidelines for National Greenhouse Gas Inventories

[56] Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.

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

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

Project emissions

The project emissions (*PE*y) are 0 t CO_2e/yr.

Leakage
According to ACM0002, leakage is also considered zero for this project activity (Ly = 0 t CO_2e/yr).

Baseline emissions
According to the procedures described in section B.6.1 and the data in Annex 3, the OM emission factor of the EGAT Grid System is 0.5716 t CO_2e / MWh and the BM emission factor is 0.4381 t CO_2e / MWh.

The Combined Margin emission factor ($EF_{grid,CM,y}$) $= EF_{grid,OM,y} \times 0.5 + EF_{grid,BM,y} \times 0.5$
$= (0.5716 \times 0.5) + (0.4381 \times 0.5)$
= 0.5048 t CO_2e/MWh.

The baseline emissions (BEy) are the electricity supplied ($EG_{PJ,y}$ in MWh) by the project activity to the grid multiplied by the baseline emission factor ($EF_{grid,CM,y}$ in t CO_2e/MWh).

$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$
$= 309,000 \times 0.5048$
= 155,983 t CO_2e.

Emission Reductions

The total emission reductions of the Project (ERy) are:
$ER_y = BE_y – PE_y$
= **155,983 t CO2e.**

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

Year	Estimation of project activity emission reductions (tonnes CO_2 e)	Estimation of baseline emission reduction (tonnes CO_2 e)	Estimation of leakage (tonnes CO_2 e)	Estimation of emission reductions (tonnes CO_2 e)
2011 (23 Sep – 31 Dec)	0	42,735	0	42,735
2012	0	155,983	0	155,983
2013	0	155,983	0	155,983
2014	0	155,983	0	155,983
2015	0	155,983	0	155,983
2016	0	155,983	0	155,983
2017	0	155,983	0	155,983
2018 (1 Jan – 22 Sep)	0	113,248	0	113,248
Total tCO_2e.	**0**	**1,091,881**	**0**	**1,091,881**

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*. This is the total of net annual electricity delivered to the grid by the Xeset II Project.
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	309,000 MWh
Description of measurement methods	The net electricity delivered to the grid by Xeset II Project is measured at Paksong Substation. The parameters will be measured continuously and

and procedures to be applied:	recorded monthly. The relevant data will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	As per EDL's Design and Distribution Manual, the meters are calibrated according to the IEC60521 IEC61036 standards. Based on this, the accuracy of the electricity meter will be 0.2. The electricity generation from the plant will be monitored and recorded on site using LANDID & GYR, type: ZMT102.2ctr14f9 (type of systems and/or technology). The project operator is to be responsible for recording this data. The CDM Manager or other relevant supervisor will check the generation data daily. Receipts from electricity sales will also obtained for double checking.
Any comment:	

Data / Parameter:	**Cap_{PJ}**
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data to be used:	Project site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	76 MW
Description of measurement methods and procedures to be applied:	Installed capacity is determined based on recognised standards. The installed capacity will be monitored annually.
QA/QC procedures to be applied:	Publicly available national / international standards will be used.
Any comment:	

Data / Parameter:	**A_{PJ}**
Data unit:	km^2
Description:	Surface area of the reservoir, measured at Full Supply Level after the implementation of the Project activity.
Source of data to be	Xeset II Feasibility Study 1999, Main Report by Norconsult

used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.18km²
Description of measurement methods and procedures to be applied:	The area of the reservoir would be measured from topological surveys, maps, satellite pictures, etc. The area of the reservoir will be monitored annually.
QA/QC procedures to be applied:	Publicly available reliable data sources will be used.
Any comment:	

B.7.2. Description of the monitoring plan:

This

This section details the steps to be taken to monitor the GHG emission reductions from the Xeset II Project and its reporting. The Monitoring Plan for this Project has been developed to ensure that from its inception, the Project is well organized in terms of the collection and archiving of complete and reliable data. The Monitoring Plan prepared for this project is based on the following approved CDM methodologies:

- Version 12.1.0 of ACM0002 (Consolidated methodology for grid-connected electricity generation from renewable sources).

The Monitoring Plan covers all the activities within the Project boundary and outlines the proposed GHG data management, control and reporting systems, e.g. instructions, procedures, record keeping systems, assumptions, technical equations, models and other means that support complete, accurate and conservative CER estimates.

The Monitoring Plan consists of the following sections:

1. Project Management / Monitoring organization

The organisation of the CDM monitoring team will be established prior to the start of the crediting period. Clear roles and responsibilities will be assigned to all staff involved in the CDM Project and the Xeset II Hydropower Plant Manager, will be nominated as the CDM Manager. The organisational structure of the CDM team is shown in Figure B-6.

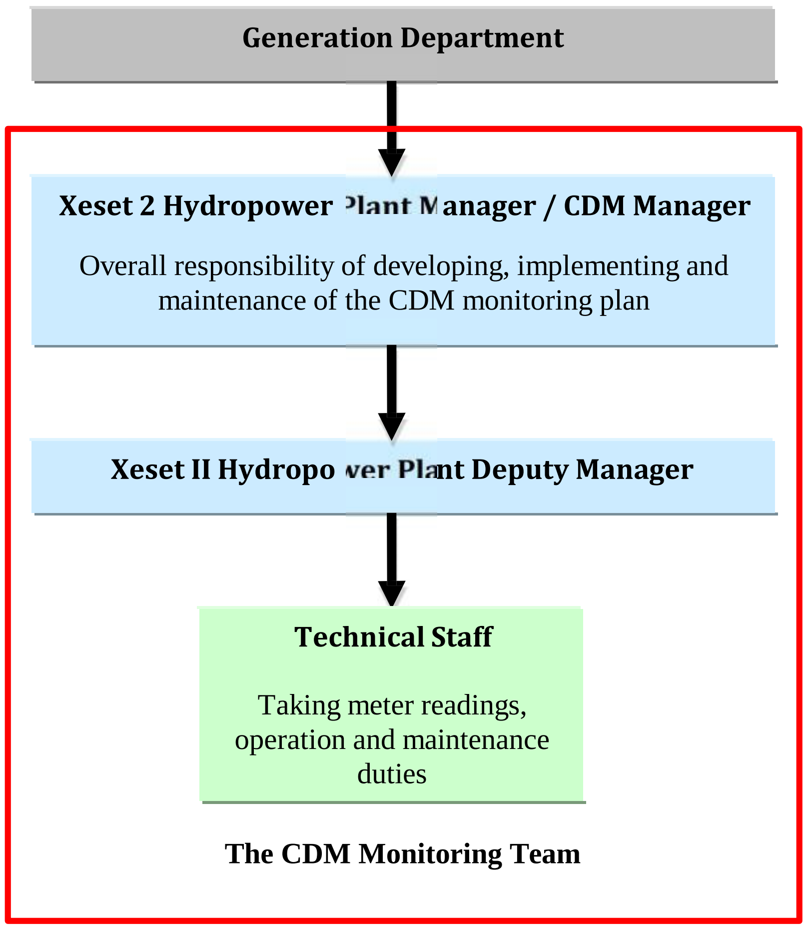

Figure B-6: Structure of the CDM monitoring team

The CDM Manager has overall responsibility of the CDM monitoring system. In the event of a trained member of the monitoring staff being absent from duties, the integrity of the monitoring system will be maintained by other trained staff. The CDM Manager will communicate with the Xeset II Hydropower Plant Manager and provide annual monitoring reports.

2. Recording of results

The process of data collection will start on the date the Project commences its operations. The data measurement procedures, Quality Assurance and Quality Control procedures, person(s) responsible and frequency of monitoring are detailed in Table 1 and 2 in Annex 4. 100% of the data are monitored at the site by means of accurately calibrated instruments and authentic procedures dedicated for the intended purposes.

The main electricity meter which measures the electricity delivered to the grid will be installed at Paksong substation. When taking electricity meter readings a detailed account of the meter, specific uncertainty levels and associated accuracy level of measurement instruments will be recorded. Data from the generation meter will be collected continuously. This information will be printed out. In addition to the automatic system an Operator based at the substation will manually record information in a log. Monthly, all the electricity generation data will be incorporated into an electronic master sheet which would act as the electricity generation data archive. Data collection on the back-up meter (at Paksong Substation) will follow the same procedures as data collection on the revenue / generation meter outlined above.

The installed capacity of the Project and the area of the reservoir after the implementation of the Project activity will be monitored annually to monitor the power density of the Project.

3. Data records management procedure.

All information such as data records, maps and drawings, Environmental and Social Impact Assessment (ESIA) and Feasibility Study reports will be kept as records and made available to the verification party. A documentation system (document register) will be developed to manage all the CDM documents and access all the records easily. All project related documents will be kept for the entire crediting period and two years thereafter. The CDM Manager has the overall responsibility for document maintenance and review. On a monthly basis, the CDM Manager will review all Project data, document registers and manage the data collection, storage and archiving of all relevant data records. The CDM Manager is responsible for preparing the annual CDM Monitoring Report.

4. Data Archiving

At the end of each month, all manually entered monitoring data will be filed electronically (e.g. spreadsheets) with paper or CD files as backup. The Project owner will keep all sales / billing invoices and records and these will be archived both electronically and manually for the entire crediting period and two years thereafter.

5. Maintenance Procedures

All equipment will be inspected regularly for functionality, integrity and corrosion. Equipment will be maintained in accordance with manufacturer's instructions. Any defective components or materials shall be reported and replacements obtained and fitted within one day if there is a possibility of total failure, or otherwise within one week. The CDM Manager will retain all maintenance documents and a Maintenance Register will be implemented.

6. Training Procedures

The CDM Manager will manage the process of training new staff, and will ensure that trained staff performs their monitoring duties. Capacity building activities and training will be provided by EDL at the beginning of the Project construction and at the start of the operation to all Project related employees. The training program will be delivered by external CDM specialists, and technical training by equipment suppliers. A Training Register will be implemented to keep track of all employee training and competence.

7. Quality Assurance / Quality Control (QA / QC) Procedures

7a) Procedures for calibration of measurement equipments

All measurement equipment (fixed and portable) will be calibrated in accordance with relevant standards (national, international or industry standards). The electricity generation meters will be calibrated according to the IEC60521 or IEC61036 standards[57]. A calibration record will be kept for every instrument irrespective of its frequency of usage and whether or not the equipment is an operational or spare unit. A Calibration Register will be maintained to keep track of all calibration records for the Project. The CDM Manager is responsible for organising the calibration and keeping all the calibration records.

7b) Internal audit procedure

Internal audits will be undertaken to ensure all procedures are being adhered to and to confirm compliance with CDM rules and quality management. The internal audit will be carried out annually and no more than two months before each verification event. The CDM Manager is responsible for ensuring that the internal audits take place.

8. Error Handling, Corrective and Preventative Actions Procedure

8a) Failure of monitoring equipment

In an event of main electricity meter failure, a backup meter shall be used in its place. If the backup meter fails, it will be replaced by an accredited equipment-testing organisation.

8b) Error handling, corrective and preventative procedure

The CDM Manager will be notified of any errors found during internal audits. Specialists will be appointed to review the implications of the error and the proposed correction procedures. In case of emergency, the Project entity will not claim emission reductions due to the Project activity for the

[57] EDL Design and Distrbution Manual, Part B, section 6, p109

duration of the emergency. A procedure will be developed to outline the responsibility and authority for handling and investigating non-conformance, taking action to mitigate any impacts caused and for initiating and completing corrective and preventive action. All non-conformances and special events reports will be recorded in a register. This register will be maintained by the CDM Manager and reviewed at the end of each crediting year.

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

The baseline study and the monitoring methodology were completed on 28/02/2012 by the CDM team of Earth Systems and Earth Systems Lao, independent consulting companies engaged by the project developer to develop the CDM project. The persons who undertook the baseline study and monitoring methodology are listed below:

List of entities determining the baseline and monitoring plan:

Earth Systems
Suite 17, 79-83 High Street
Kew, Victoria Australia 3101
Email: nigel.murphy@earthsystems.com.au
Tel: +61 (0)3 9810 7500
Fax: +61 (0)3 9853 5030

Earth Systems Lao
015 Ave. Kaysone Phomvihane
PO Box 2582
Vientiane capital, Lao PDR
Email: bouavong@earthsystemslao.com
Tel: +856 21 413723
Fax: +856 21 416563

Please note that neither the persons named nor Earth Systems / Earth Systems Lao are a project participant in this Project.

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:

17th October 2005 (Purchase of equipment)

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

30 years, 0 months

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:

23/09/2011

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

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

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An initial environmental assessment for the Project was completed in 1999, followed by a formal Environmental and Social Impact Assessment (ESIA) in 2004. The ESIA was approved by the Science Technology and Environment Agency (STEA) of the Prime Minister's Office of Lao PDR in 2004.

In addition to the ESIA, a Public Consultation and Disclosure Plan (PDCP) and an Environment and Social Action Plan (ESAP) were submitted as stand-alone reports in 2004. Numerous specialist studies were commissioned as part of the impact assessment process including terrestrial biodiversity, aquatic ecosystems, land use, health and nutrition, household socioeconomic surveys, archaeology and cultural heritage and water utilisation. Community and government consultation was undertaken at all stages of the ESIA process.

The environmental impacts and relevant management and mitigation measures are summarised below:

<u>Biodiversity and ecosystems</u>

The impact on terrestrial biodiversity is expected to be minor. A small amount (less than 20 Ha) of forest land will be permanently lost as a result of the Project. Appropriate management and mitigation measures are in place to minimise the disturbance of existing vegetation and to prevent any further degradation. Where possible the Project proponent has located site infrastructure away from potential areas of conservation value and disturbed areas will be progressively re-vegetated. The ESIA indicated that the loss of forest due to the Project would not have a major impact on wildlife throughout the region nor would it threaten rare or endangered species. The Project is not located in a conservation or wildlife protection area. Appropriate biodiversity management and mitigation measures have been adopted.

Aquatic ecosystem impacts are expected to be minor in the Xeset River and the Houay Tapoung River, which are already regulated rivers. The ESIA identified no endangered or rare aquatic species that are likely to be threatened by the Project and no species loss is expected.

Construction impacts on aquatic ecosystems will be controlled by an appropriate management and mitigation program that reduces soil erosion and entrained sediments. For the maintenance of aquatic and wildlife systems in the dewatered sections of the Xeset river below the diversion, a downstream mitigation flow of 0.5 m^3/s will be provided. A mitigation flow of 0.2 m^3/s will be provided in the Houay Tapoung and Houay Pao. These flows will be measured by gauging stations and monitored by the Porject proponent as per the Environmental and Social Action Plan prepared for the Project.

<u>Land use</u>

Land use impacts were assessed by detailed mapping which included the use of satellite imagery. The construction of the canal from the Houay Tapoung diversion and the Xeset II head pond will result in some impacts on agricultural land, with a maximum of 92.7 ha of swidden land and 36 ha of coffee plantation affected. Compensation for these land assets has been paid to the owners of these agricultural assets.

No other infrastructure or houses are affected by the Project. No resettlement is required.

Water quality and sediment deposition

Whilst there will be flow changes in the Houay Tapoung and Xeset Rivers there is expected to be little impact on water quality. The Xeset II head pond covers a small area and is expected to have very little impact on water quality characteristics.
There will be the potential for sediment release during construction, and for a build up of suspended sediments and downstream sediment deposition, however management and mitigation measures will be adopted to rehabilitate disturbed areas and reduce sediment entering the river system.

No upstream watershed stabilisation programs are needed so long as the present system of land use, which favours permanent cover, continues. Should the system deteriorate and result in excessive erosion, the head pond design has the ability to cope with high sediment load situations.

The catchment has a low sediment yield and sediments that will be deposited in the head pond will not adversely affect the head pond as these will be flushed through the head pond.

Soil Quality

The ESIA indicated that there is no significant soil pollution that can be expected from the development of the Project. There are no metals or acidity within the soil profile that can be leached into the drainage.

Air /Dust and Noise

The major air emissions associated with the Project are expected to be dust emissions during construction. Noise emissions will also be most significant during construction.

No villages are located close to the construction areas. Dust and noise will be monitored during construction and, if necessary, management measures such as the use of road watering trucks and sound barriers will be implemented to reduce project dust and noise emissions.

Culturally Significant Sites, Resources and Activities

The survey of the direct impact zones of the Project concluded that there are no physical or cultural resources of significance that are threatened by the Xeset II Project.

Management measures have been implemented during construction to ensure that any chance finds are provided to the Government of Lao PDR in accordance with the Decree of the President of the Lao People's Democratic Republic on the Preservation of Cultural Historical and Natural Heritage 1997.

Potential Project-related impacts on culturally significant activities such as fishing and agriculture have been minimised through compensation programs for the loss of coffee trees and swidden areas, community fishpond development in villages affected by reduced fisheries resources, and water management strategies to ensure adequate downstream irrigation water is available for dry season rice cultivation.

Social impacts and community safety

Apart from the provision of employment opportunities within the Project Area, benefits are also expected in the improvement of access, services and facilities. Community safety will be managed through community education programs and the provision of suitable signage and traffic control through village areas.

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:

The proposed project has no significant impacts on the environment. The ESIA of the proposed project has been approved by the Science Technology and Environment Agency (STEA) of the Prime Minister's Office of Lao PDR in 2004.[58]

SECTION E. Stakeholders' comments

>>

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

>>

Community consultation for the Xeset II environmental assessment process commenced in 1999 and was completed in 2004. In total 17 meetings were held at villages in the project area with 1007 people consulted (323 women and 684 men). Community consultation associated with the development of the Project has been ongoing from 2004 to the present date.

1999 Consultation

In 1999 consultations were held with local communities and with government. A total of five public consultation meetings were held in different parts of the Project covering:

- Ban Laongam (District centre and Houay Tapoung diversion);
- Ban Setkhot (upstream of the Project); Ban Dong (Houay Tapoung diversion);
- Ban Keppheung (downstream irrigation area on Houay Tapoung); and
- Ban Samia (downstream irrigation area in lower Houay Tapoung). In total, 24 villages were selected and 230 people participated in the meetings, including the village heads, representatives of female groups, youth organisations and the community.

[58] The Environmental and Social Impact Assessment (ESIA) for Xeset II run-of-river hydropower project was approved and compliance Certificate No: 2350 was issued on November 2004.

Two government consultation workshops were held in 1999: one at Xeset River on 20 April and the other in Ban Laongam on November 3 and 4. The major purpose of these workshops was to present the project outline and preliminary findings to government representatives at all levels – national, provincial and district. Non-government organisations (NGOs) and other relevant stakeholders were also involved, including representation from the United Nations Development Programme (UNDP) and the Mekong River Commission.

The community residing at the Houay Tapoung diversion area (including Ban Laongam, Ban Dong and their surrounding villages) were mainly concerned about the diversion and water supply issues. The villagers from Keppheung and Ban Samia and their surrounding areas were focused on water supply and irrigation issues.

2004 Consultation

Extensive further consultation was conducted in April and May, 2004 for the update and completion of the Environmental and Social Impact Assessment. There were 17 meetings held at villages in the project area. The total number of people who attended the village consultation meetings were 1,007 people. Of these, 323 were women (32%) and 684 were men (68%).

In the first round of consultation in April 2004, the village meetings were specifically aimed at disseminating information and ascertaining early feedback on proposed environmental and social impact mitigation measures. These meetings were conducted in an informal style, with the aim of promoting open discussion of critical issues.

Three government consultation workshops were held in April, two at District government level and one at Provincial level. The participants included the relevant government ministries at District and Provincial level, village chiefs, representatives of the Lao Women's Union, the Lao National Front and the Lao Youth Organisation.

Major concerns and issues discussed in the meetings included water resource use, water quality, road upgrades and safety, livestock and community safety, as well as compensation and community support programs.

Due to the gender imbalance in the three consultation meetings, two additional workshops inviting more than 130 female villagers and children were held at Ban Dong Noy and Ban Laongam to ensure their active participation and engagement in the community consultation process. The major concerns of the local women were water supply and health facilities. The results of the consultations provided key input into the ESAP to ensure women's interests were represented.

These issues were identified in the ESIA process, and management and mitigation measures developed accordingly and detailed in an Environmental and Social Action Plan (ESAP).
A further phase of community consultation was conducted in June to present the results of the environmental assessment process and the draft ESIA reports.

There was general support for the Xeset II Project and the management and mitigation that had been developed for the project.

All community and government consultation is documented in the Public Consultation and Disclosure Plan (PCDP) which was prepared as part of the ESIA process.

2008 Consultation

A stakeholder consultation was held on 27 November 2008 in Ban Dasia – Phonhin village, with the local community in the CDM registration process and to obtain feedback on the impacts of the Project[59]. Approximately 50 people attended the meeting.

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E.2. Summary of the comments received:

>>

The stakeholder consultation process identified that the local community was broadly supportive of the Project but identified the following aspects of importance to the community:

- Minimising the impact on water supply during certain periods of the year for irrigation (e.g. rice cultivation);
- Minimising impacts on water quality management;
- Minimising dust pollution associated with construction and road upgrades;
- Minimising noise pollution during construction and operation;
- Promoting greater power supply in the region;
- Providing fair and adequate compensation for lost agricultural land to minimise the impact on livelihoods;
- Prioritising employment and business opportunities to the local communities;
- Ensuring livestock and community safety;
- Assistance in improving community health; and
- Improving road access and road safety

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

>>

The public consultation process provided important forums for community perspectives and concerns to be heard and integrated into the assessment. The Environmental and Social Action Plan and the management and mitigation measures developed for the Project reflects this community input. These include:

- Monitoring and Risk Management Programs;
- Community Consultation and Awareness Program;
- Compensation Implementation Program;
- Village Water Supply Program;

[59] See EDL Minutes of the Meeting 27.11.09

- Community Fish Pond Project; and
- Community Trust Fund.

Some examples of specific management and mitigation measures adopted include:

- Minimising agricultural land impacts by limiting the clearance around the Houay Tapoung canal;
- Establishment of an erosion control program during construction to reduce soil erosion and sedimentation;
- Use of a downstream mitigation flow of 0.5 m^3/s to maintain downstream aquatic ecosystems;
- Noise suppression for day time and night time operations;
- Dust control on the construction site and the roads; and
- Adequate compensation for the loss of productive land, forest and other household assets.

To ensure that the community is fully informed and that the views of the community are considered during the development process an ongoing public consultation and involvement program has been developed. Key areas for ongoing consultation include the community fishpond development program, village water supply program, and Community Trust Fund. Local stakeholders will remain involved in future decisions through various programs such as the Community Consultation and Awareness Program and the Water Resource Committee. Future stakeholders will also be engaged during the CDM Validation process.

The projected income from the sale of CERs can be expected to assist the project owner, EDL, in implementing the Environmental and Social Action Plan for the Project and more broadly contribute to sustainability and socio-economic initiatives in the region[60].

[60] Letter to the Lao DNA, 18.5.09, p3

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Electricite Du Laos (EDL)
Street/P.O.Box:	PO Box 309
Building:	Nangbone Road
City:	Vientiane
State/Region:	
Postcode/ZIP:	
Country:	Lao PDR
Telephone:	+856 21 451537, 451519
FAX:	+856 21 416381, 263794
E-Mail:	edlgmo@laotel.com
URL:	
Represented by:	
Title:	
Salutation:	Mr
Last name:	Inthirath
Middle name:	
First name:	Khammany
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal e-mail:	

Organization:	Vitol S.A.
Street/P.O.Box:	Boulevard du Pont-d’Arve, 28 CH 1205
	PO BOX 384, 1211
City:	Geneva 4
State/Region:	
Postcode/ZIP:	
Country:	Switzerland
Telephone:	+41 22 322 11 11
FAX:	+41 22 781 66 11
E-Mail:	dbf@vitol.com

URL:	
Represented by:	
Title:	
Salutation:	Mr
Last name:	Fransen
Middle name:	
First name:	David
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal e-mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

The Project did not receive any public funding from Parties included in Annex I of the UNFCCC for the construction of the project. The Norwegian Agency for Development Co-operation (NORAD) provided funding for the initial feasibility assessment of the Project.

Annex 3

BASELINE INFORMATION

The transmission (115 kV and above) connections From Lao PDR to Thailand (EGAT) are as follows:

From	To	Voltage, kV	
		Installed	Operated
Nam Theun Hinboun P.S.	Nakon Phanom (EGAT)	230	230
Houay Ho P.S.	Ubon Ratchani 2 (EGAT)	230	230
Phonetong S.S (Vientiane)	Udon Thani 1 (EGAT)	115	115
Phonetong S.S	Udon Thani 2 (EGAT)	115	115
Thanaleng S/S (Vientiane)	Nongkhai (EGAT)	115	115
Pakxan	Boungkan (EGAT)	115	22
Thakhek	Nakhon Phanom (EGAT)	115	22
Savannakhet (Pakbo)	Mukdahan 2 (EGAT)	115	115
Bang Yo (Pakse)	Sirindikhom HPS/ Ubon Ratchathani (EGAT)	115	115

Source: Lao Power Development Plan 2005 - 2013

Lao PDR historical import and export data is shown below (million of KWh)

Year	Generation	Import sale	Export sale	Domestic sale
1981	845.90	8.39	708.70	105.12
1982	910.45	10.66	749.76	107.37
1983	863.38	13.37	694.42	124.01
1984	890.98	16.63	709.72	127.47
1985	906.62	18.60	716.28	130.39
1986	867.31	17.20	683.59	128.15
1987	566.61	18.00	387.25	125.53
1988	552.65	19.80	363.61	139.10
1989	698.02	23.09	490.54	149.20
1990	820.56	27.73	595.19	164.58
1991	834.61	34.90	562.59	220.67
1992	751.81	41.27	459.82	252.74
1993	919.64	47.70	595.79	264.31
1994	1,198.32	57.46	829.25	303.41
1995	1,084.99	76.83	675.55	337.47
1996	1,247.84	87.56	792.43	379.54
1997	1,218.74	101.65	710.21	433.86
1998	947.78	142.28	405.20	513.27
1999	1,168.88	172.20	598.14	565.55
2000	1,578.55	159.92	862.94	639.86
2001	1,553.65	182.50	796.38	710.33
2002	1,570.20	200.80	771.43	766.74
2003	1,316.84	229.34	434.66	883.74
2004	1,416.45	277.58	507.05	902.76
2005	1,751.05	325.63	727.75	1,011.06
2006	1,639.30	334.55	547.05	1,112.40
2007	**1,398.371**	**475.94**	**267.97**	**1,298.41**

Source: EDL Annual Report 2007

Plant factors for existinand planned hydropower pro_jects in Lao PDR*

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Somce: Power Development Plan 2007-2016, Appendix 3-7, Table 3.2.6
*The highlighted section consist of existing plants

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TABLE 7 EXISTING NATIONAL GRID HYDRO POWER PLANTS IN 2007

ชื่อโรงไฟฟ้า (ที่ตั้ง)	กำลังการผลิตสูงสุด (เมกะวัตต์) ULTIMATE CAPACITY (MW)	จำนวนเครื่องกำเนิดไฟฟ้า (จำนวน x เมกะวัตต์) No.OF UNITS AND CAPACITY (No.* MW)	กำลังการผลิตติดตั้งรวม (เมกะวัตต์) TOTAL INSTALLED CAPACITY (MW)	ค่าเฉลี่ย AVERAGE: ระดับน้ำ (เมตร-ระดับน้ำทะเลปานกลาง) WATER LEVEL (m-msl)	ค่าเฉลี่ย AVERAGE: ปริมาณน้ำเข้า (ล้านลูกบาศก์เมตร) ANNUAL INFLOW (m.cu.m)	ค่าเฉลี่ย AVERAGE: ปริมาณน้ำที่ปล่อย (ล้านลูกบาศก์เมตร) ANNUAL OUTFLOW (m.cu.m)	การผลิตพลังงานไฟฟ้า (ล้านกิโลวัตต์ชั่วโมง) GENERATION (Gwh)	NAMES OF POWER PLANTS (LOCATION)
กฟผ.								EGAT
เขื่อนภูมิพล (ตาก)	779.2	6*82.2	493.20	248.3	6,587.2	7,877.2	2,163	BHUMIBOL (TAK)
		1"115	115.00					
		1•171	171.00					
เขื่อนน้ำพุง (สกลนคร)	6	2"3	600	280 g	179.2	126.7	25	NAt.r rwcHOt t.oAK".;ot.l)
เขื่อนอุบลรัตน์ (ขอนแก่น)	25 2	3"8,4	25 20	179 5	1562.1	1Q75.1	83	!...ROC.RATAL\(1O'O1K.4,9.
เขื่อนสิรินธร (อุบลราชธานี)	36	3"12	3600	1<0.0	1,987.5	1.1141.8	124	S<RN)HC::fiN.(U6Ct. AATCHA–H.\.1)
เขื่อนจุฬาภรณ์ (ชัยภูมิ)	.00	2"20	4000	750.5	148.2	79.4	72	C1LLABHORN {Ct-AJYAo-....uw)
เขื่อนสิริกิติ์ (อุตรดิตถ์)	500	4"125	500.00	1g.9	5.040.8	6,737.3	1,243	SIRI<IT (trTTA-"\AOIT)
เขื่อนแก่งกระจาน (เพชรบุรี)	19.0	1. "9.0	"9.00	94.1	1,056.1	718.5	74	KHK; KR..tat {?fTCHABII)
เขื่อนศรีนครินทร์ (กาญจนบุรี)	720	3"120	360.00	175.0	5.386.3	5.877.8	1,585	IND(KCI-t,&NA,BURI;
		2"180	360.00					
เขื่อนบางลาง (ยะลา)	n	3"24	72.00	108.0	2.507.9	1,782.9	283	IW'IGL"-G (YAI.A)
เขื่อนห้วยกุ่ม (ชัยภูมิ)	1.'	1"1.06	1.06	306.1	100.0	48.5		HUAIKUW (CKt.IYAP......)
เขื่อนบ้านสันติ (ยะลา)	!.3	1"1.275	1.275	331.4	15.7	"5.7		!W< S.O.'fT1(YA1Aj
เขื่อนท่าทุ่งนา (กาญจนบุรี)	39	2'0.5	39.00	58.7	5.002.3	4.99!.3	209	THATt1G K6.(KN..C
เขื่อนบ้านยาง (เชียงใหม่)	0.125	2"0.056	0.112	NA	NA	N.A.	0	bAH YA.•r;(CttiAt..IG MAI)
		1"0.0125	0.0125					
เขื่อนบ้านขุนกลาง (เชียงราย)	0.20	2"0.09	0.20	N.A.	N.A.	N.A.	1	SAN KHIJH IQ.A.IG (Ct1W'IIG M';
		1"0.02						
เขื่อนช่องกล่ำ (ปราจีนบุรี)	0.02	1"0.02	0.02	N.A.	N.A.	N.A.		C><Ci..c>ICL'M ("IAAn!H;UIIII
เขื่อนวชิราลงกรณ (กาญจนบุรี)	300	3"100	300.00	148.0	5.863.7	5.5311.8	an	V..-LCH<liCOIIN(IW>C""........,I
เขื่อนแม่งัด (เชียงใหม่)	9	2"4.5	9.00	389.0	332.6	192.2	21	•..e NG.t.T{Ct«N«l•Wl
เขื่อนรัชชประภา (สุราษฎร์ธานี)	240	3"80	240.00	88.3	2605.0	2.576.3	471	t<o\(SIJIIATIWIl)
เขื่อนห้วยกุยมั่ง (กาญจนบุรี)	0.1	1-'Q.1	0 10	NA.	N.A.	N.A.		OfJAj KUI 11-'HG (KN<CIWWIUIUj
เขื่อนปากมูล (อุบลราชธานี)	136	4*34	136.00	N.A.	N.A.	N.A.	106	PAK MUN (UBOL RATCHATHANI)
เขื่อนลำตะคอง (นครราชสีมา)	500	2*250	500.00	N.A.	N.A.	N.A.	615	LAMTAKHONG (NAKHON RATCHASIMA)
พพ.								DEDE
เขื่อนแม่ฮ่องสอน (แม่ฮ่องสอน)	1	1*0.85	0.85		run off the river		5	MAE HONG SON (MAE HONG SON)
เขื่อนแม่กึมหลวง (เชียงใหม่)	3.2	2"16	3.20		Nn off the river		11	MAE KUM LUANG (CHIANG MAI)
เขื่อนห้วยแม่ผง (พะเยา)	086	1"0.86	086		N.A	N.A	2	HIJAIt.Vr.f PHONG I?HA YAO)
เขื่อนแม่สะเรียง (แม่ฮ่องสอน)	1 25	2"0625	1.25		run off the river			M.6.:: SAENG {f-1.\:G SC›f
เขื่อนไอกะเปาะ (นราธิวาส)	020	2"0.1	0.20		run off the river			(WV.TI-"WAT)
เขื่อนคีรีธาร (จันทบุรี)	12	2"6.1	12 20	202 _	NA	N.A.	22	KI(-ni&JIU)
เขื่อนบ่อแก้ว (เชียงใหม่)	0.2	2"0.1	020		run off the river			BOKAE'N"(CI-...!IG t.tAI}
เขื่อนแม่มาว (เชียงใหม่)	4.6	2"'2. 1es	4 33	683.0	N.A.	N.A.	7	t.\.6.: MI\0 (CK4,NG A.W)
เขื่อนแม่สาป (เชียงใหม่)	1.36	2"0.68	1 36	528.6	N.A	N.A.	3	MA SloP (CtfAIG MAr
เขื่อนแม่สะงา (แม่ฮ่องสอน)	5.04	2"2.52	5.04	488.4	NA	N.A.	24	t.\6.: SA-NGA \A! SON)
เขื่อนแม่หาด (เชียงใหม่)	<.0	2"0 <09	0.88		run oft the nver		3	I.tI\! 1-W>{CI1.ANG1.\4,,
เขื่อนแม่ตืน (เชียงใหม่)	0.25	-125	0.25		run oft the rrver		0	M4,! TUEN (CHIAhG JIAI)
เขื่อนคลองลำปลอก (พัทลุง)	2.0	2"'0.591	1.182		run otf the nver			KICf.IG L''t A..OK[->ArAJ.J..e.iG)
เขื่อนน้ำขมึน (พิษณุโลก)	2.0	2'0.515	1.030		run ott the nver			twlf K'1At.(I.II (PhlITSMIULO<)
เขื่อนห้วยแม่ตอก (เชียงใหม่)	1.0	2"0.33	0.66		run on the nver			HUA.1 W.A! $OT (Ct-_.."IG l.tAr,.
เขื่อนคลองดุสน (สตูล)	0.68	2"0.34	0.68		run on the nveJ			KLONG ru SOH (!)AilH}
เขื่อนห้วยปะทาว (ชัยภูมิ)	4.5	2"2.25	450	454.0	NA	N.A.	16	HUAI PA,C'1AIYAPHU
เขื่อนกิ่วลม (ลำปาง)	0.4	2"0175	0.35		run on the NVer			KII!W LOt.JPNIG}
เขื่อนห้วยลำสินธุ์ (พัทลุง)	▮	2"0•79	0.958		run on the nv.r			HUN IAM SIN \»An.AI..U'ro)
เขื่อนลำพระเพลิง (นครราชสีมา)	0.85		0.850		run on the m.'ti'			LAMPHAA Ptt..O!NO(AT01ASIW-}
เขื่อนห้วยน้ำขุ่น (เชียงราย)	1.8	2*0.850	1.700		run off the nve			""""..... IOU<{CIW<GIW)
เขื่อนห้วยยะโม่ (ตาก)	0.85	1*0.850	0.850		run off the riv«			
กฟภ.								
เขื่อนแม่เตย (เชียงใหม่)	2.0	1*2.00	2.00		run oft tM nv.,.		10	1.\t.f THCEJ tatAHCif.W)
เขื่อนแม่ยะ (เชียงใหม่)	1.0	1"1.0	1.00		run off the nv«		6	t.tt.f YA fCHIA. WI) NI'\
เขื่อนขุนแป๊ (เชียงใหม่)	0.1	1"0.09	0.09		off the rtv'lf			KIJN PI£ (C>OAI -IMI)
เขื่อนแม่เตียน (เชียงใหม่)	2	2'0965	1.93		rvn off the rfvt>r			t.tt.f 1AIN(CH.AMG t.W.
เขื่อนแม่ใจ (เชียงใหม่)	'	1"0.80	0.80		run off the river			t.\A.f .IAJ t()IANG1/.Af}
เขื่อนแม่ปาย (แม่ฮ่องสอน)	2.0	2"1.00	2.00		NI'\ off the rever			MAo: P (Mo\f HONG c;cJN)
โครงการห้วยตั้ง (เชียงใหม่)	004	'"0 037	0.037		run off the nwr		0	HUAI KHANG (CHIANG MAI)
รวม			3,475.348				8,114	TOTAL

ที่มา : พพ. กฟผ. กฟภ. และผู้ผลิตไฟฟ้าพลังงานหมุนเวียนขนาดเล็กมาก — Sources : DEDE, EGAT, PEA , and VSPP.

หมายเหตุ : "0" หมายถึงตัวเลขที่มีค่าน้อยกว่า 0.5 — Note : Data shown as "0" means figure is less than 0.5

รายงานไฟฟ้าของประเทศไทยปี 2550 / ELECTRIC POWER IN THAILAND 2007 9

Somce: *Electric Power* in *Thailand 2007,* Table 7, p9, Department of Alternative Energy Development and Efficiency (DEDE) Ministry of Energy (www.dede.go.th).

Plant factors for selected hydropower plants in Thailand, 2007

Hydropower Plant	Installed Capacity (MW)	Generation (MWh)	Plant factor (%)
Ubol Ratana (Khon Kaen)	25.2	83,000	37.6
Sirindhorn	36	124,000	39.3
Bang Lang	72	283,000	44.9
Chulabhorn	40	72,000	20.5
Pak Mun	136	106,000	8.9
Vaijiralongkorn	300	876,000	33.3
Srinagarind	360	1,585,000	50.3
Rajiprasha	240	471,000	22.4

Source: based on data of existing hydropower plants in Thailand obtained from *"Electric Power in Thailand 2007"*, Table 7, p9, Department of Alternative Energy Development and Efficiency (DEDE) Ministry of Energy (www.dede.go.th).

Emission Reduction Calculations:

1. **Calculate the Operating Margin emission factor(s) ($EF_{grid, OM,y}$)**

In determining the Simple OM we apply the above emission factors to the most recent generation data available for plants on the grid excluding the low cost/must run options. The generation data is aggregated for the SPP (small power producers) which consist of fossil fuel and renewables, we have therefore apportioned generation from this category on the basis of the capacity of units that fall within the renewable/non-renewable generating types. The following table details the calculation of the Simple OM. In some cases the plants may operate on a number of fuels, i.e. natural gas and furnace oil, in these cases we apply the most conservative emission factor (the lowest) to the plant in order to determine the emissions.

In the case of the calculation of the Simple OM we have used 3 years worth of data and therefore hold the resultant Simple OM constant over the first crediting period.

The emission factor calculations are based on the emission factor of the electricity system in Thailand published by the Thailand Ministry of Energy [61].

Table 1: CO2 emission coefficient of each fuel type

Fuel Type	Net Calorific Value (NCV)		CO2 emission coefficient		
	MJ/Unit	Unit	tCO_2/TJ	tCO_2/Unit	Unit
Natural gas	1.02	MMscf	56.10	57.22	MMscf
Fuel oil	39.77	m litres	77.40	3,078.20	m litres
Diesel oil	36.42	m litres	74.10	2,698.72	m litres
Lignite	10.47	kg	101.00	1,057.47	k tonnes
Imported coal	26.37	kg	94.60	2,494.60	k tonnes

Table 2: Simple Operating Margin (OM) (for the EGAT Grid System)

Fuel Type		Fuel Consumption[1]		Generation[2]	CO_2 emissions
	Symbol		$FC_{i,y}$	EG_y	
	Unit	unit	FC / unit	GWh	tCO_2
2005 (excl. SPPs)					
Natural Gas		MMscf	764,118	85,703	43,724,360
Fuel oil		m litres	1,996	8,244	6,144,083
Diesel oil		m litres	83	414	223,994
Coal & Lignite[3]		k tonnes	16,571	18,334	17,523,335

[61] *Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.*

Fuel Type		Fuel Consumption[1]	Generation[2]	CO_2 emissions
Symbol		$FC_{i,y}$	EG_y	
Unit	unit	FC / unit	GWh	tCO_2
2005 SPPs				
Natural Gas	MMscf	92,273		5,280,046
Fuel oil	m litres	13		39,414
Diesel oil	m litres	0		1,170
Imported Coal	k tonnes	858	13,700[4]	2,141,556
Electricity Imports to EGAT[5]			4,419	0
2006 (excl. SPPs)				
Natural Gas	MMscf	857,103	86,339	49,045,148
Fuel oil	m litres	2,030	8,350	6,248,742
Diesel oil	m litres	41	143	110,648
Coal & Lignite	k tonnes	17,166	22,051	18,152,530
2006 (SPPs)				
Natural Gas	MMscf	91,503		5,235,985
Fuel oil	m litres	8		23,440
Diesel oil	m litres	0		1,178
Imported Coal	k tonnes	866	13,731	2,161,550
Electricity Imports to EGAT			5,159	0
2007 (excl. SPPs)				
Natural Gas	MMscf	783,137	88,166	44,812,665
Fuel oil	m litres	936	3,646	2,881,193
Diesel oil	m litres	23	174	62,071
Coal & Lignite	k tonnes	19,650	28,716	20,779,286
2007 (SPPs)				
Natural Gas	MMscf	94,725		5,420,354
Fuel oil	m litres	7		21,470
Diesel oil	m litres	1		3,370
Imported Coal	k tonnes	899	14,559	2,242,231

Fuel Type		Fuel Consumption[1]		Generation[2]	CO_2 emissions
	Symbol		$FC_{i,y}$	EG_y	
	Unit	unit	FC / unit	GWh	tCO_2
Electricity Imports to EGAT				4,491	0
				406,339	232,279,818
				$EF_{grid, OMsimple,y}$	**0.5716**

Sources:

[1] Electric Power in Thailand 2007, Table 19, p 23

[2] Electric Power in Thailand 2007, Table 17, p 21

[3] Emissions from coal & lignite are calculated based on CO2 emission coefficient of lignite (Mae Moh)

[4] Electric Power in Thailand 2007, Table 20, p 24

[5] Electric Power in Thailand 2007, Table 22, p 25

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

In considering the BM we are required to calculate the carbon emissions factor based on an examination of recent capacity additions to the grid. These capacity additions should be chosen from the greater generation accounted for:

• The five power plants that have been built most recently, or

• The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Table 3: ***Selection of Sample group for Build Margin***

	Energy (MWh)
Total Generation (MWh) in 2007	144,026,386
20% of the total generation	28,805,277
Five power plants built most recently	8,881,929

The total generation of the grid under consideration (EGAT grid system with extension to Lao PDR) amounted to 144,026,386 MWh, of which 20% is equal to 28,805,277 MWh. The five most recent plants only account for less than this amount and therefore the sample to determine the BM is selected on the basis of the “power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently”.

Table 4: Sample group of power units used to calculate the Build Margin.

Power plant / Company	Date Commissioned	Type of Fuel	Installed Capacity (MW)	Generation (GWh)
Gulf Power Generation Co.Ltd. - Thailand (1)	1st March 2007	Natural Gas	734	
BLCP Power Limited - Thailand (1)	13th August 2006	Coal/Lignite	673	
Glow IPP Ltd. - Thailand (1)	31st January 2003	Natural Gas & Diesel	713	
Eastern Power & Electric Ltd. - Thailand (1)	25th March 2003	Natural Gas & Diesel	350	
Ratchaburi Unit 1 - Thailand (1)	18th April 2002	Natural Gas & Fuel oil	2,041	
Ratchaburi Unit 2 - Thailand (1)	1st November 2002	Natural Gas & Diesel		
			Total EGAT generation	**34,491**
Nam Mang 3 Hydropower* - Lao PDR (2)	2004	Hydro	**40**	**138**
			Total EGAT Grid and the extension to Lao PDR generation	**34,629**

Sources:

(1) Dr. Hinchiranan, S. (2009). The estimation of emission factor for an electricity system in Thailand 2007. Bureau of Energy Research, Department of Alternative Energy Development and Efficiency, Ministry of Energy.

(2) Electricité du Laos (EDL), Annual Report 2007, Statistics of Energy Generation and Distribution, Page 17. Available at: http://www.edl-laos.com/annual_report_2007.php#modules=statistics.

Table 5: Build Margin emission factor in 2007

Fuel type	Unit	Fuel consumption[1]	Generation[2]	CO_2 emissions
		$F_{i,m,y}$	$EG_{m,y}$	
			GWh	(tCO_2)
Hydropower[3]		0	138	0
Natural gas	MMscf	193,997.00	34,491	11,100,896
Diesel oil	m litres	3.60		9,724
Coal & Lignite	k tonnes	3,838.93		4,059,548
		Total	*34,629,000*	*15,170,168*
		($EF_{grid, BM,y}$)		**0.4381***

* Thailand Build Margin emission factor is 0.4398tCO_2

Sources:

(1) & (2) Energy statistic sector, Alternative Energy and Efficiency Information Centre (DEDE)

Note: The information of generated electricity and fuel usage of each power plant is treated as strictly confidential.
(3) Electricité du Laos (EDL), Annual Report 2007, Statistics of Energy Generation and Distribution, Page 17. Available at: http://www.edl-laos.com/annual_report_2007.php#modules=statistics.

3. Calculation of the baseline Emission Factor

The weights applied to the OM and BM are fixed at 0.5, therefore in order to calculate the combined margin we apply these to the Simple OM and BM as calculated above. The following table shows this calculation arriving at the combined margin of 0.5048 tCO_2/MWh.

Table 6: Calculation of the Combined Margin

	tCO_2/MWh
Simple OM, $EF_{grid,OM, y}$	0.5716
Build Margin $EF_{grid,BM, y}$	0.4381
Combined Margin, $EF_{grid,CM,y}$	0.5048

Annex 4

MONITORING INFORMATION

CDM Monitoring Procedures

Table 1: CDM Monitoring targets and personnel responsibility

Procedure	Target	Responsibility	Achievement deadline
Staff training	This procedure identifies the responsibilities of all CDM staff and provides necessary training to the relevant personnel.	CDM Manager	Prior to operations
Data collection	This procedure details the steps to collect the data from the revenue meter and the back-up meter, and record the data correctly.	CDM Manager and On-site technician	Prior to operations
Record keeping	This provides detailed procedures of data collection and record keeping. The purpose is to ensure that complete and accurate data is recorded under the QA / QC system. The data will be maintained and archived in an appropriate manner.	CDM Manager and Project Developer	Operations
QA / QC	This details the steps to check data collected on site before being kept and archived. All measurement equipment (fixed and portable) will be calibrated in accordance with relevant standards.	CDM Manager and Project Developer	Operations
Electricity meter maintenance	This procedure outlines the steps to provide regular inspection on both of the revenue meter and the back-up meter.	CDM Manager and Maintenance technician	Operations
Equipment calibration	This details the process of equipment calibration in accordance with relevant national standards	CDM Manager and Maintenance technician	Operations
Emergency response	This details the procedures of undertaking appropriate responses to any emergencies (e.g. equipment failure, accidents, etc.)	CDM Manager	Operations

Table 2: Operational procedures and responsibilities for CDM monitoring and QA/QC procedures (E – responsible for executing the task, R – responsible for QA/QC, I – to be informed, N/A – not applicable)

Task	On-site Technician	CDM Manager	Project Developer	Maintenance Technician	ESL
Data collection	E	R	N/A	N/A	N/A
Data record	N/A	E	R	N/A	N/A
Data reporting and record keeping	N/A	E	R	N/A	I
Monthly and annual report preparation	N/A	E	E/ R	N/A	I
Calibration and maintenance	I	R	I	E	I
Emergency response	I	E/ R	I	I	N/A