 <p align="center">Project design document form for small-scale CDM project activities (Version 06.0)</p>	
<p><i>Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for small-scale CDM project activities" at the end of this form.</i></p>	
<p align="center">PROJECT DESIGN DOCUMENT (PDD)</p>	
Title of the project activity	Chao Phraya Hydropower Project
Version number of the PDD	10
Completion date of the PDD	09/05/2016
Project participant(s)	Electricity Generating Authority of Thailand
Host Party	Thailand
Sectoral scope and selected methodology(ies), and where applicable, selected standardized baseline(s)	<u>Sectoral Scope 01</u> : Energy Industries (Renewable /non-renewable sources) <u>Project Type I</u> : Renewable Energy Projects <u>Project Category I.D</u> : Grid Connected renewable energy generation. Version 17 with reference to EB 61
Estimated amount of annual average GHG emission reductions	34,967 tCO ₂ /year

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09/2015

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> *Chao Phraya hydropower project* is a small-scale greenfield run-of-river hydroelectric power plant with an installed capacity of 12.4 MW at Chao Phraya river. Prior to implementation of the project activity, there are two existing water ways for Chao Phraya river: 1) Main water way (pass through the Chao Phraya irrigation dam) and 2) By-pass water way (left bank of the Chao Phraya irrigation dam). There are no any hydro power projects for both water ways. The project, is implemented on the left bank of the existing Chao Phraya irrigation dam by using the by-pass water flow to generate the electricity. The proposed project developed by the Electricity Generating Authority of Thailand (EGAT) will utilize the water resource of the Chao Phraya river approximately 180 km North of Bangkok.

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The proposed project includes installation of two generator of 6.2 MW installed capacity each and two turbines of 6.4 MW installed capacity each at 6.6 kV, which will be stepped up to 22kV and exported from the Chao Phraya Powerhouse to existing Provincial Electricity Authority (PEA) transmission line. All the net generated electricity will be exported to the PEA. Since the project activity generates electricity by using renewable hydro resources with the total capacity of 12.4 MW, the project activity is fall into type I (Renewable energy project) and small scale project (the installed capacity <15 MW).

Deleted: The purpose of the project activity is to generate electricity

The electricity generated from, the project activity would reduce GHG emissions produced by the grid which is currently dominated by fossil fuel based power plants. Emission reduction from hydroelectric power projects arise as they replace grid electricity with a zero-emission source of electricity generation.

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Project activity will reduce greenhouse gas of about 34,967 tCO₂e annually throughout crediting period of 7 years or the total of emission reductions is 244,769 tCO₂e for entire of 7-year crediting period.

The project activity is not applied as a part or a CPA in any CDM PoAs.

The project activity will contribute to sustainable development within the following broad categories:

Socio-economic:

The proposed project activity contributes to poverty alleviation through income and employment generation for the local community by employing people at all levels from unskilled labour to skilled manpower throughout the construction and operation of the project activity. The project activity also helps diversify the sources of electricity generation, which is important for meeting growing energy demands and transition away from fossil fuel based electricity generation. The project activity will lead to the development of basic amenities leading to an improvement of living standard of the community. The project activity will also improve the roads in the vicinity of project activity, which will benefit the communities in the area. Furthermore the project provides community support and coordination such as donation and assistance to the local schools, eye care for the poor in the community, setting up reforestation programmes, organizing energy conservation programmes for children, child care support, etc.

The project will also contribute to the Thailand Community Development Fund. Revenues from the project will be paid into the Community Development Fund proportionate to the amount of electricity generated. These funds will be made available to representatives of local communities surrounding the power plant for use in community development projects.

Environment:

The Project will diversify the sources of electricity generation by displacing conventional fossil fuel-based¹ power generation with carbon-neutral hydro power generation, and hence GHGs emissions associated with the combustion of fossil fuels would be reduced.

¹ Refer to Appendix 4

Technology:

The turbine generator for the project activity has been manufactured and imported from China, therefore, positively contributing to technological development of Thailand through the transfer of technology. This would encourage other project promoters and pave way for the country to be technologically self reliant in future.

A.2. Location of project activity

A.2.1. Host Party

>> Thailand

A.2.2. Region/State/Province etc.

>> Chai Nat Province

A.2.3. City/Town/Community etc.

>> Amphor Sapphaya

A.2.4. Physical/Geographical location

>> The project is located in Sapphaya district in the Chai Nat province, of Thailand. The plant site has geographical coordinates with latitude of 15°09'31.05" N' and longitude of 100°10'40.27" E. Below figure shows the location of the project.

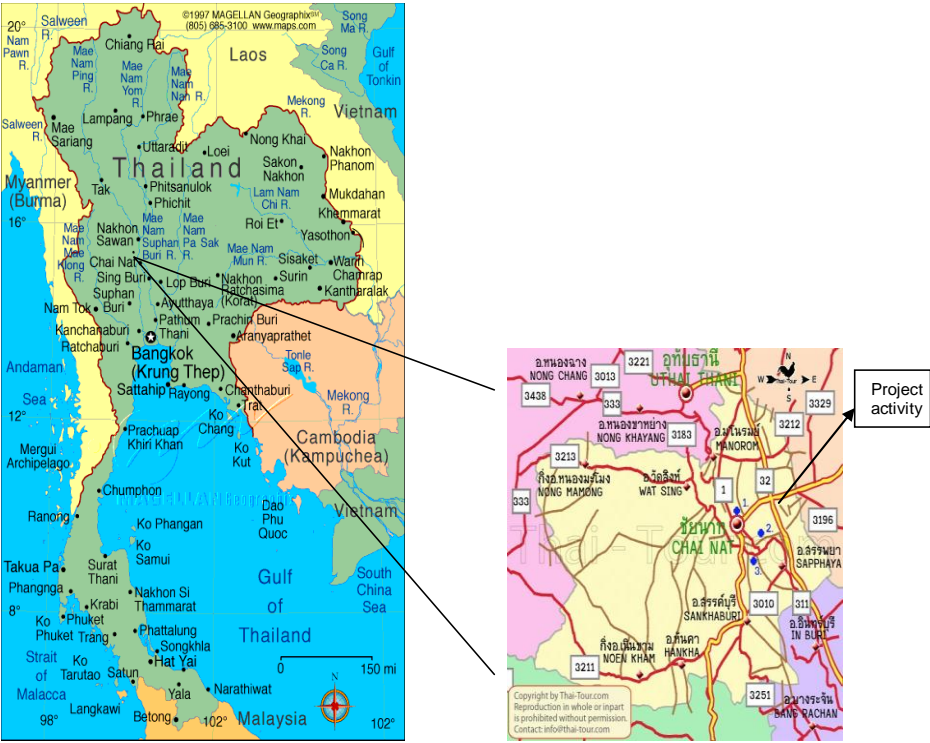


Figure 1 Location Map of the Project Activity

A.3. Technologies and/or measures

>>

1. The project activity falls into:

Sectoral Scope 01: Energy Industries (Renewable/non-renewable sources)

Project Type I: Renewable Energy Projects

Project Category I.D: Grid Connected renewable energy generation. Version 17

2. Technology to be employed by the project activity

The proposed project activity is the installation of a run-of-river hydro power generation project with installed capacity of 12.4 MW. The project produces renewable energy by utilizing hydro power as an energy source and converting the potential energy available in the water flow into mechanical energy using turbine and then to electrical energy using generators.

The installed capacity of each generator is 6.2 MW and there are total of 2 generators installed resulting in a total installed capacity² of 12.4 MW. This is less than the limit of 15 MW for renewable energy project activities to qualify under Type I project activities. As per the provisions of indicative simple baseline and monitoring methodologies for small scale CDM project activities Type I.D. "comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal, and renewable biomass, that supply electricity to a national or a regional grid". With above considerations, the Type I.D. is the most appropriate category for the project activity.

The project involves installation of two turbines of 6.4 MW each to produce electricity at 6.6 kV which will be stepped up to 22kV to export from the Chao Phraya Powerhouse to existing PEA transmission line. The turbines are Horizontal Bulb Tubular type with a design head of 7.2 m and design discharge of 97.30m³/s per unit. The turbine generator shaft rotates at a speed of 125 rpm. Start up electricity for auxiliaries of turbine will be imported from PEA to open a guide vane, which is a part of the turbine controlling the water flow to the turbine. The backup power supply in the event of power plant shut down (in case of emergency and Power plant maintenance) will be grid supply. All the electricity imported from the grid will be monitored.

The guide vane consumes very small amount of electricity from PEA at the first starting up. Project emissions for start up of guide vanes have not been accounted for since this is part of the baseline. However, during operating period, electricity consumed by guide vanes are taken account of as auxiliary consumption.

² General Guidelines for SSC CDM Methodologies (Version 18)

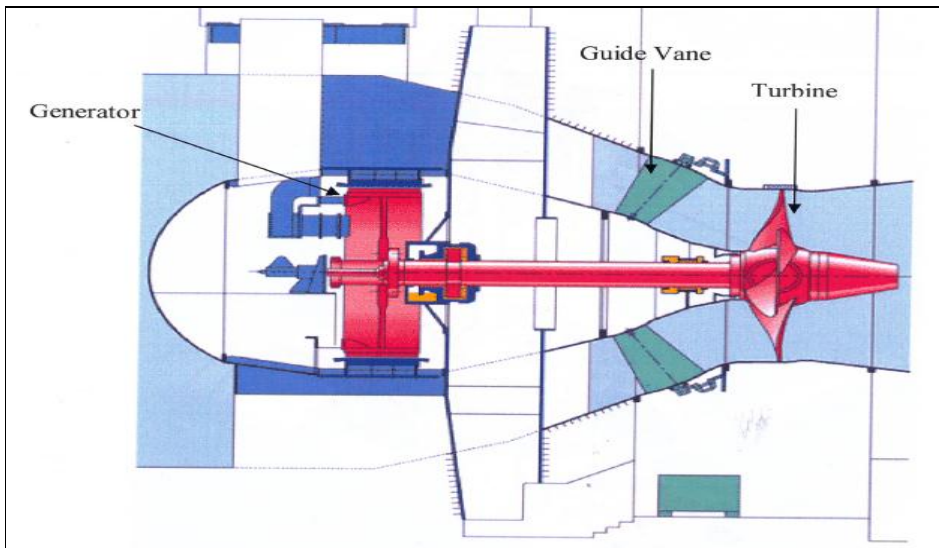


Figure 2 Bulb Turbine and Generator

The power plant is expected to run 365 days a year at a gross plant load factor (PLF) of 58.78% producing 63,849 MWh of electricity. 1.5% of the gross generation is assumed to be used up as auxiliaries for station service equivalent to 958 MWh. These auxiliaries are deducted from gross generation to arrive at a net electricity generation of 62,891 MWh. It is assumed that there will be no import of electricity from the grid except for start up of the power plant. However, all electricity import will be accounted in to calculate *the quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity* ($EG_{BL,y}$)³.

In order to calculate baseline emission, EGAT will monitor the electricity supplied to the grid ($EG_{export,y}$) and the electricity purchased from the grid ($EG_{import,y}$) for the project activity, and from these two data, the net grid-connected electricity generation ($EG_{BL,y}$) will be calculated ($EG_{BL,y} = EG_{export,y} - EG_{import,y}$).

The main technical parameters are as below:

Table 1

	Parameter	Value	Source
TURBINE	Quantity	2	Specification of the Equipment Document and Cross Section drawing
	Head	7.2m	
	Discharge	97.3 m ³ /s	
	Speed	125 rpm	
	Rated Output	6.4 MW	
	Type	Horizontal Bulb Tubular Turbine	
GENERATOR	Rated capacity	7,294 kVA	
	Rated power	6.2 MW	
	Rated voltage	6,600 V	

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³ Refer to Section B.6.1

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	Rated frequency	50 Hz	
	Rated Speed	125 rpm	
	Rated power factor	0.85	
	Number of phases	3	
	Units	2	

3. Environmentally Safe Technology:

The strict environmental protection measures will be taken for the project activity according to Initial Environmental Evaluation (IEE) report, so the project is safe to environment.

4. Technology Transfer:

The turbines is manufactured by Tianjin Tianfa Heavy Industry Hydroelectric Power Equipment Manufacture Co. Ltd, China and imported to Thailand by The Consortium of Sino Hydro Corporation Limited and Italian-Thai Development Public Company Limited.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Thailand (Host)	Public Entity: Electricity Generating Authority of Thailand	No

A.5. Public funding of project activity

>> The project activity has received no public funding and there is no diversion of the Official Development Assistance (ODA) funds.

A.6. Debundling for project activity

>> Appendix C, paragraph 2 and 3 of the Simplified Modalities and Procedures for Small-Scale CDM project activities states:

“A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

- With the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point.

The project proponent confirms that there are no other small-scale CDM projects with the same project participants that have been registered within 1 km of the project boundary of the proposed small-scale activity within the previous 2 years.

Furthermore, it is confirmed that the proposed project activity is not a debundled component of a large scale project activity.

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

B.1. Reference of methodology and standardized baseline

>> The approved baseline and monitoring methodology used for this project activity is AMS-I.D “Grid connected renewable electricity generation”, version 17⁴

Methodology also refers to following tool:

Version 02.2.1 - Tool to calculate the emission factor for an electricity system (EB 63)⁵;

Reference: Guidelines on the Demonstration of Additionality of Small-scale project version 09.0 (EB 68, Annex 27)⁶

B.2. Project activity eligibility

>>

Project type: Type I

Category: D

The proposed small scale project activity meets the eligibility criteria as proposed in approved baseline methodology AMS-I.D, Version 17. Applicability of the methodology is justified as below:

Table 2

	Applicability criteria	Justification
1	This category comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity to a national or a regional grid.	<u>The proposed project activity generates power by utilizing the water of Chao Phraya River. The electricity supplied by the project activity to the grid will replace existing and planned electricity generation at the National grid, the majority of which is Combined Cycle and Thermal power based, which is evident from the data used for the calculation of the emission factor of Thai grid (Annex: 3, step: 3).</u>
2	This methodology is applicable to project activities that (a) install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).	The proposed project activity consists of the installation of a new power plant at a site where there was no renewable energy power plant operating prior to its implementation and, therefore, it falls under item (a) and it is eligible to apply this methodology.
3	Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology: - The project activity is implemented in an existing	<u>The project activity has no reservoir and it is implemented on a run-of-river. Thus, this criterion is not applicable for the project activity</u>

Deleted: The project activity is the generation of hydro power that will be fed into the national grid.

Deleted: The proposed project activity is implemented on an existing reservoir with no change in the volume of reservoir.

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⁴ <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved>

⁵ http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v4.0.pdf/history_view

⁶ https://cdm.unfccc.int/Reference/Guidclarif/meth/methSSC_guid05.pdf

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	reservoir with no change in the volume of the reservoir; - The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m2; - The project activity results in new reservoirs and the power density of the power plant is greater than 4W/m2.	
4	"In the case of biomass power plants, no other biomass types than renewable biomass are to be used in the project plant.	This project does not consist of biomass power plant. This is not applicable.
5	If the new unit has both renewable and non-renewable components (e.g., a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the unit cofires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW	The project does not incorporate a mix of renewable and non-renewable components. The project involves the installation of <u>two</u> turbines of <u>6.4</u> MW <u>each</u> and <u>two</u> generators of <u>6.2</u> MW <u>each</u> thus remaining under the 15_MW limit required by the methodology.
6	"Combined heat and power (co-generation) systems are not eligible under this category.	The proposed project consists <u>of</u> new hydro power plant and, hence, it is not a combined heat and power (co-generation) system.
7	In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15MW and should be physically distinct from the existing units.	There was no power generation on site before the project activity hence this paragraph is not applicable.
8	In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.	There is no existing power generation on the site of the project activity thus negating this condition.

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Therefore, according to the criteria and conditions mentioned above, the project activity will remain under the limits and it qualifies as a small-scale project activity.

B.3. Project boundary

According to the baseline methodology:

The project boundary encompasses *the physical, geographical site of the renewable generation source*

The project boundary includes the equipments installed for the operation of a new hydro power plant – the main elements of which are the turbine generator and the transformers.

In terms of gases, the project boundary is restricted to CO₂. For the purpose of the project activity the relevant grid is defined by the power generating units serving the same grid as the project activity. The boundary for the calculation of the grid emission coefficient is the Thai national grid.

The below diagram clearly explains the project boundary of the project activity.

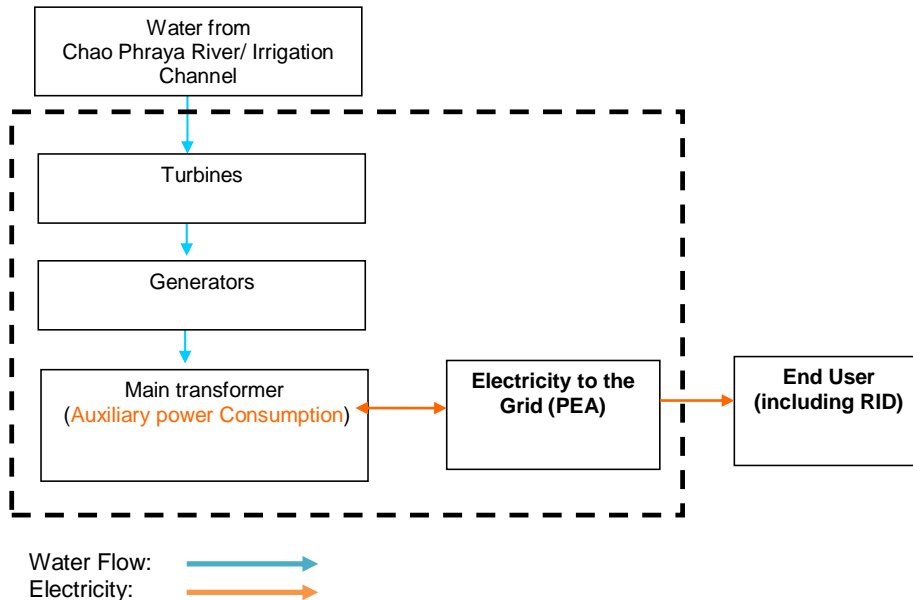


Figure 3 Project boundary

B.4. Establishment and description of baseline scenario

>> As the project activity is the installation of renewable energy generation units and it is supplying electricity to Thai grid, according to Para 11 and 12 of approved methodology of AMS.I.D., Version 17, baseline scenario is *the electricity delivered to the Thai grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid.*

The baseline emissions are the product of electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the project activity multiplied by the grid emission factor.

$$BE_y = EG_{BL,y} * EF_{CO_2,grid,y}$$

Where:

BE_y	Baseline emissions in year y, (tCO ₂)
$EG_{BL,y}$	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year y (MWh)
$EF_{CO_2,grid,y}$	Thai grid CO ₂ Emission Factor in year y, (tCO ₂ /MWh)

The Emission Factor is calculated in a transparent and conservative manner as follows:

(a) *A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the 'Tool to calculate the Emission Factor for an electricity system'.*

OR

(b) *The weighted average emissions (in kg CO₂e/kWh) of the current generation mix. The data of the year in which project generation occurs must be used.*

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Calculations must be based on data from an official source (where available) and made publicly available.”

The project proponent has opted for approach ‘a’ i.e. combined margin emission factor and desired to keep the emission factor constant throughout the crediting period for the sake of adopting more simple approach for calculation of emission reductions.

The emission factor has been fixed ex-ante for the crediting period and has been calculated according to the Tools of CDM UNFCCC website.

Key Information and Data Used to Determine the Baseline Scenario⁷

	tCO ₂ /MWh
Simple OM, EF _{OM, y}	0.543
Build margin EF _{BM, y}	0.569
Combined margin, EF_y	0.556

B.5. Demonstration of additionality

>> In line with the *Guidelines on the Demonstration of Additionality of Small-scale project version 09.0 (EB 68, Annex 27)*, the Project is deemed to be additional if it faces at least one of the following barriers:

- (a) Investment barriers
- (b) Technological barriers
- (c) Barrier due to prevailing practice
- (d) Other barriers

The most important barrier to the incorporation of the Project Activity is the investment barrier.

Investment barrier:

The main barrier to the project is the investment barrier. To analyze the feasibility of the project, the project proponent has conducted an Equity internal rate of return (IRR) analysis for the project activity. Since the project is 100% equity financed, PP has considered equity IRR as suitable financial indicator.

Suitability of benchmark:

Paragraph 12 of “Guidelines on the Assessment of Investment Analysis” (EB 62, Annex 5) states:

*In cases where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR. **Required/expected returns on equity are appropriate benchmarks for an equity IRR.** Benchmarks supplied by relevant national authorities are also appropriate if the DOE can validate that they are applicable to the project activity and the type of IRR calculation presented.*

Since both public and private companies can develop hydro power project in Thailand, benchmark shall be based on the parameters that are standard in the market. The equity IRR is selected as the financial indicator to demonstrate additionality of the project.

Benchmark:

The Cost of Equity has been calculated based on parameters which are standard in the market and which were available at the time of the board decision (10th Jan 2008). The average

⁷ Detail calculation is in Appendix 4

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cost of equity financing is calculated from the formula from the Stock Exchange of Thailand (SET)⁸ website.

Calculation details

EGAT is a power generation company and hence will be categorized under Energy & Utilities sector of SET index. The general stock market sector Energy and Utilities includes 26 companies involved in a diverse range of activities which includes: operation of water pipeline systems, manufacturing of electrical equipment, aviation fuel services, manufacturer/distribution of petroleum based products and petroleum fuel refining/sales. For the purpose of calculating the benchmark, only companies involved in the production/sale of electricity have been included in the list of companies. Companies involved in manufacturing, petroleum fuel refining, water pipeline management, etc. are excluded because they do not face the same risk profile as the project activity. Additional information is provided in the Benchmark spreadsheet to demonstrate how the companies have been classified.

Formula: $ROE = \text{Net profit after taxes} / \text{year } n \div [(\text{Equity} / \text{year } n - 1 + \text{Equity} / \text{year } n) / 2]$ ⁹

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Table 2

Listed Electricity Generation Companies in Thailand ¹⁰					
Symbol	Company	ROE 2005	ROE 2006	ROE 2007	Average
BANPU	Banpu Public Company Limited	24.73%	16.32%	21.87%	20.98%
EGCO	Electricity Generating Public Company Limited	13.83%	18.14%	21.89%	17.95%
GLOW	Glow Energy Public Company Limited	17.08%	21.76%	17.26%	18.70%
RATCH	Ratchaburi Electricity Generating Holding Public Co.	20.24%	18.45%	16.15%	18.28%
SCG	Sahacogen (Chonburi) Public Company Limited	18.81%	20.70%	16.59%	18.70%
SPCG	SPCG Public Company Limited	22.32%	26.43%	8.14%	18.96%
3 YEARS AVERAGE:		19.50%	20.30%	16.99%	18.93%

The calculated ROE is 18.93% over the three year¹¹s prior to the decision to invest in the project (2005-2007). The benchmark obtained from the above calculation is consistent with paragraph 13 of the investment guideline.

"In the cases of projects which could be developed by an entity other than the project participant the benchmark should be based on publicly available data sources which can be clearly validated by the DOE. Such data sources may include local lending and borrowing rates, equity indices, or benchmarks determined by relevant national authorities."

In addition, the return on equity for EGAT's recent build power plants¹² is approximately 30%.

However, in the webhosted PDD, the benchmark was mentioned as 13.21% which is calculated based on data from third party consultant (Stern Stewart & Co.) and Thai Bond Market, thus to be conservative, this benchmark has been used for analysis.

⁸ http://www.set.or.th/en/market/market_statistics.html

⁹ This formula is obtained from http://www.set.or.th/th/market/files/SET_Formula_Glossary.pdf (page 15)

¹⁰ Source: <http://www.set.or.th/en/company/companylist.html>

¹¹ Annual Report of Glow Energy Public Company Limited and SPCG Public Company Limited are not publicly available for year 2003 and hence 5 yr average is not calculated.

¹² Songkla Combined Cycle power plant project and South Bangkok combined cycle power plant project

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The cost of equity has been determined based upon the Capital Asset Pricing Model (CAPM).

$$R_e = R_f + \beta_l(MRP)$$

Where:

R_e	Expected return on equity
R_f	Risk free return on an investment
β_l	Equity Beta (levered)
MRP	Market Risk premium

Table 3.

No.	Parameter	Symbol	Value	Source
1	Risk free return on investment	R_f	5.07%	Thai Government Bond yield (http://www.thaibma.or.th)
2	Market risk premium	MRP	8.00%	EGAT internal document : Report prepared by Stern Stewart & Co.
3	Equity Beta (unlevered)	B_u	0.50	EGAT internal document : Report prepared by Stern Stewart & Co.
4	Equity Beta (levered)	B_l	1	Calculated ¹³
5	Debt Equity Ratio	D/E	1.48	EGAT internal document : Report prepared by Stern Stewart & Co.
6	Tax Rate	t	30%	Corporate tax rate in Thailand
7	Cost of Equity	R_e	13.21%	Calculated

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Using the above values we arrive at a cost of equity of **13.21%** as a conservative and appropriate benchmark for the project activity.

The parameters of Investment Analysis have been produced in the table below:

Table 4.

Parameter	Unit	Value	Source
Total Investment	THB 1000	850,720	FSR (excluding financing fee)
Construction Period	Yrs	4	FSR
Operation & maintenance cost	THB 1000/annum	13,277	EGAT estimate based on "Prasae hydro project Feasibility Study"
Escalation in O&M Cost	%	Nil	Conservative assumption
RID Payment	THB 1000/annum	21,102	MoU signed between Royal Irrigation Department (RID) and EGAT on 17-Apr-07.
Insurance	%	0.75% of Investment Cost	EGAT insurance cost for "Songkla Combined Cycle power plant project"
Interest on Working Capital	THB 1000/ annum	865	Assumption: Interest on 1 month of electricity sales
Working Capital Interest Rate	%	7.21%	Annual average Min. Lending Rate
Land Rent	THB 1000/annum	509	Letter from Office of Chainat Area Treasury regarding Land rent in Chai Nat province before board decision date

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¹³ Levered Beta is calculated from the formula: levered beta = Unlevered Beta * [1 + (1 - Tax Rate) * Debt / Equity]

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Community development fund			NEPC Resolution Document
- Cost during Construction	THB/MW	50,000	NEPC Resolution Document
-Cost during Operation	THB/ MWh	20	NEPC Resolution Document
Equity	%	100	EGAT announcement and "Public debt management Plan for fiscal year 2008" dated 19-Oct-07 from EGAT.
Project Life Time	Yrs	30	EGAT contract with RID for water use
Depreciation		Straight line method	EGAT annual report
Salvage Value	THB 000	Nil	EGAT annual report
Tax	%	30	Thailand corporate tax rate
Tariff	THB/kWh	2.30	EGAT Time of Use (ToU) document
CER price	US\$/CER	22.09	Calculated: Annual average issued CER price from GTZ monthly report
Exchange Rate	THB/US\$	32.1	Calculated: Average annual exchange rate from www.oanda.com
Annual average CERs	tCO2/year	34,967	Calculated
Benchmark	%	13.21%	Calculation based on data from 3 rd party Consultant "Stern Steward & Co., Ltd" and Thai Bond Market.

In the analysis of the revenues we have calculated the net export of electricity to the grid, based on which the project activity will be paid. Applying the applicable electricity tariff of THB 2.30 per kWh to the resultant exports provide the revenues for the project activity. This tariff is fixed for the life of the project.

The electricity generation parameters are as follows:

Table 5.

Electricity generation	
Capacity, MW	12.4
PLF %	58.78%
Annual generation, MWh	63,849
Electricity to RID, MWh	250
Auxiliaries, %	1.50%
Exports, MWh	62,891
Tariff, THB/kWh	2.30

Adopting the above mentioned assumptions, the cash flow has been calculated for a period of 30 years. The analysis arrives at equity IRR of 6.72% without considering the revenues from the CDM and the benchmark considered is 13.21%. It is therefore clearly demonstrated that the project activity is not a financially attractive course of action on a business-as-usual basis being below the expected equity return of 13.21%.

Plant load factor:

As per EB 48 annex 11, the plant load factor shall be defined ex-ante in the CDM-PDD according to one of the following three options:

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- (a) The plant load factor provided to banks and/or equity financiers while applying the project activity for project financing, or to the government while applying the project activity for implementation approval;
- (b) The plant load factor determined by a third party contracted by the project participants (e.g. an engineering company);

PLF has been calculated by Civil & Hydro Engineering Division of EGAT based on the historical discharge data from Royal Irrigation Department and simulated by specific spreadsheet program. This PLF has been submitted to Cabinet (*government organization*) for *project implementation approval process*. Moreover, PLF has also been verified by an independent third party engineer (member of Council of Engineers, Thailand).

Sensitivity analysis

The sensitivity analysis has been done in accordance with EB 62, Annex 5 '*Guidelines on the Assessment of Investment Analysis (version 05)*' paragraph 20 and 21. As per the tool the project's viability is evaluated through a change of $\pm 10\%$ in the parameters which have a major impact on the returns from the project:

1. Initial investment cost
2. Electricity tariff
3. Plant load factor
4. Recurring cost

1. The hydro project is expected to have investment cost over runs due to increase in the development period. Thus, in line with the tool $\pm 10\%$ changes have been given to the initial investment cost.

Initial Investment cost	-10%	Base Case	+10%
Without CDM IRR	7.52%	6.72%	6.00%

The IRR without CDM crosses the benchmark if the investment cost decreases by 60%. However it should be noted that the Investment cost is unlikely to reduce by 60%.

2. The electricity tariff has also been given $\pm 10\%$ sensitivity since it has a major impact on the project returns.

Electricity tariff	-10%	Base Case	+10%
Without CDM IRR	5.54%	6.72%	7.81%

The electricity tariff of 2.30 THB/kWh considered in the financial analysis of the project activity has been taken from the most recent published TOU document of EGAT which was available before the board decision date. With an increase in electricity tariff by 75% (4.02 THB/kWh) the equity IRR becomes 13.76% and thus crosses the benchmark applied for the project activity. However, it is unlikely that tariff could increase by 75%.

3. The output in a hydro project is mainly dependent on the flow and availability of water and hence the PLF. Since PLF has a significant effect on the financial returns of the project, these have been varied by $\pm 10\%$.

PLF	-10%	Base Case	+10%
Without CDM IRR	5.55%	6.72%	7.81%

The IRR without CDM reaches the benchmark if the PLF increases by 75% i.e. PLF of 102.87%. However such a situation is not expected to occur as the PLF has already been

CDM-SSC-PDD-FORM

calculated based on historical discharge data recorded by the Royal Irrigation Department and has also been certified by a third party chartered engineer.

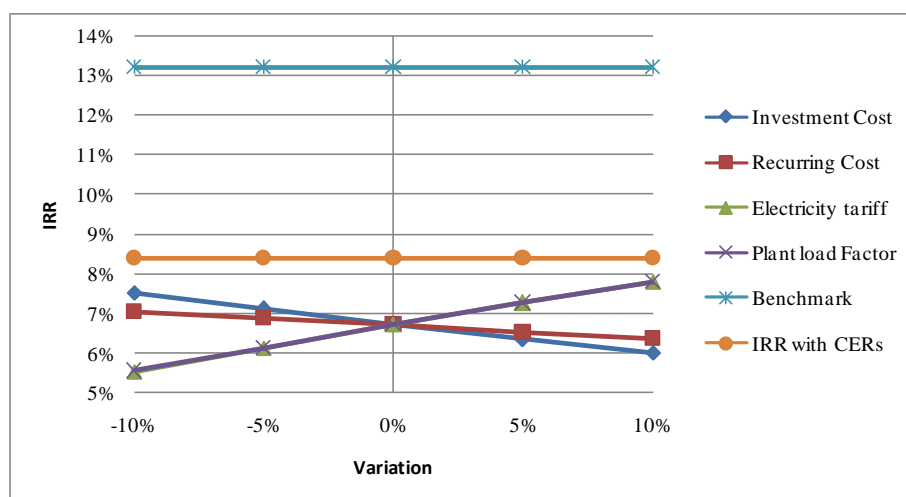
- The Recurring costs include O&M cost, payment to RID for water usage, insurance, interest on working capital, land rent, community development fund. It has also been given a $\pm 10\%$ sensitivity since it has impact on the project returns.

Recurring Cost	-10%	Base Case	+10%
Without CDM IRR	7.06%	6.72%	6.37%

If the Recurring cost is reduced to nil, the IRR is 9.88%, which is still below the benchmark. This is a highly unrealistic situation since these operational expenses are required to be incurred to run a power plant.

The above results have been shown graphically below and it is evident that the project is not financially viable without the CDM revenues. The registration of the project activity as a CDM project and obtaining carbon finance helps mitigate these risks and CDM is thus a deciding factor in proceeding with the project.

Graph 1 : Sensitivity



Power Generation Scenario in Thailand– Prevailing practice

It is important to highlight some salient features of electricity generation in the country. Thailand is one of the fastest developing economies in the region and rapid growth in the GDP has lead to increased power demand every year. The total national installed capacity in 2007 was 28,815MW, up by 5.5% from the previous year.¹⁴

2007	Installation		Generation	
Installed capacity	MW	%	GWh	%
Combined cycle	12,238	43.30%	69,648	49%
Thermal power plant	9,297	32.90%	50,123	35%

¹⁴ <http://www.dede.go.th/dede/fileadmin/upload/cc/ElcThai110951.pdf>

CDM-SSC-PDD-FORM

Hydro	3,475	12.30%	8,114	5.66%
Cogeneration power plant	2,388	8.40%	14,545	10%
Gas turbine power plant	847	3.00%	901	1%
Diesel power plant	29	0.10%	30	0%
Gas Engine	8	0	14	0%
Others	3	0	3	0%

The above figures clearly demonstrate that the installed capacity of hydro power plants is merely 12%. The total electricity generated by the hydro power plants accounts only for the 5.7% of the national grid generation as opposed to approximately 47% and 35% by the combined cycle and thermal power plants respectively. It is evident that fossil fuel based power plants have a significant share in the country's power generation in comparison to hydro power plants that have a small share. Furthermore, the 15 year power development plan of Thailand states that natural gas, coal fired and nuclear power plants will constitute a majority of future generation capacity.¹⁵

The above statistics highlight the lack of initiatives and investments in the hydro power sector. It is therefore imperative to promote such projects with the help of benefits from the CDM.

What is more is that it has been several years since EGAT has built new hydro power plants, the last one of which was constructed in 1992. Difficulty in justifying investments in hydro power plants in the country has been one of the main reasons for EGAT not to venture into such projects.

Therefore, despite the prevailing practice EGAT has taken the initiative to set up the hydro power plants with the aim of generating clean energy which will help in the reduction of global GHG emissions. The power generated from these projects will help in meeting the ever increasing power demand of the country.

CDM consideration

EB62 Annex 13 provides guidance on the demonstration and assessment of prior consideration of CDM.

Project activities with a start date before 2 August 2008 must demonstrate the following:

(i) Awareness of CDM prior to the project activity start date and that the benefits of the CDM were a decisive factor in the decision to proceed with the project.

(ii) Continuing and real actions were taken to secure CDM status for the project in parallel with its implementation.

The start date of a project is defined in the CDM Glossary of terms as follows:

'the start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity. This, for example, can be the date on which contracts have been signed for equipment or construction/operation services required for the project activity.'

The first contract associated with implementation/construction of the project was the EPC agreement (work order) signed on 12/03/2008 with Ital Thai and Sino Hydro Corp. This is considered as the project start date. In relation to this start date, prior consideration of CDM is demonstrated as follows:

¹⁵ <http://uk.reuters.com/article/oilRpt/idUKBKK33166120070409>

CDM-SSC-PDD-FORM

Demonstration of awareness of CDM consideration prior to project activity start date, and that the benefits of the CDM were a decisive factor in the decision to proceed with the project

EGAT has considered the CDM since the inception of the project and has made continuing and real efforts to secure CDM registration of the project since that time. On 07/11/2006, governor of EGAT announced that a CDM committee has been created and have briefly discussed about the responsibilities of the CDM committee members. On 17/08/2007, governor of EGAT announced the guideline to develop CDM projects to reduce GHG emission. Thereafter, on 10/01/2008, EGAT took a decision to develop this project under the CDM as reflected on CDM EGAT committee's decision.

Demonstration that continuing and real actions were taken to secure CDM status for the project in parallel with its implementation

EGAT took a decision to develop this project under CDM on the 10/01/2008 as reflected on EGAT policy on CDM.

A detailed project timeline is provided below which demonstrates by means of reliable evidence, that continuing and real actions were taken to secure CDM status for the project in parallel with its implementation.

Date	Key event	Evidence/Remarks
07-Nov-06	Creating CDM committee and members.	EGAT order No. 95/2549
17-Aug-07	Announcement of Guideline to develop CDM project to reduce GHG	Announcement Report Copy 18/2550
10-Jan-08	Board Meeting about developing the proposed project activity as pilot CDM project along with a solar project and four more hydro projects- (Board decision date)	Board Minutes of meeting Copy
12-Mar-08	(official CDM project start date)	
12-Mar-08	Start of procurement of equipments/ work order	EPC contract agreement with ItalThai & Sinohydro Corp.
03-Apr-08	Submission of the CDM consultation proposal from Agrinergy	The CDM consultation proposal submitted by Agrinergy.
May-Jul 2008	Agreement discussed with CDM consultant	Emails/Letters exchanged
09-Sep-08	Agreement executed with a CDM consultant	The CDM consultation agreement with Agrinergy.
04-Feb-09	EGAT's hydro CDM project has been announced as the stakeholder notice	Naewna newspaper article
19-Feb-09	Organised a site visit for members of Tambon Bangluang Municipality, Amphoe Sapphaya, Chinat Province to observe the operations at Mae Somboonchon Hydropower Project at Amphoe Mae Tang, Chingmai Province. At the visit the CDM project was discussed and benefits of hydro project was highlighted.	

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CDM-SSC-PDD-FORM

20-Feb-09	Conducted a site visit for executives and members of Tambon Bangluang Municipality, Amphoe Sapphaya , Chai Nat Province at Mae Moh Lignite Mine Museum, Lampang Province. During the meeting the CDM aspect of the project was discussed. The participants also gained knowledge on pollution control and environmental protection measures implemented by EGAT.	
29-Jun-09	Meeting at Or Bor Tor Tambon Bangluang 's meeting room with local representative	Public Consultation Report
30-Jun-09	Meeting at Or Bor Tor Tambon Ta-look 's meeting room with local representative	Public Consultation Report
Aug-09	Completion of the Initial Environmental Evaluation (IEE) report	The IEE report.
Events related to validation		
31-Aug-09	Agreement with DOE (Tuv Nord)	Validation Agreement
12-Sep-09	PDD web hosted on UNFCCC	
19-23 Nov 09	Desk Review & Site Visit	
24-Mar-10	Host Country Approval	HCA letter from DNA (TGO)

B.6. Emission reductions

B.6.1. Explanation of methodological choices

>>

Baseline Emissions (BE_y)

In line with paragraph 11 of the methodology, the baseline emissions have been calculated by the following formula:

$$BE_y = EG_{BL,y} * EF_{CO_2,grid,y} \quad \text{Equation 1}$$

Where:

BE_y Baseline emissions in year y, (tCO₂)
EG_{BL,y} Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year y (MWh)
EF_{CO₂,grid,y} Thai grid CO₂ Emission Factor in year y, (tCO₂/MWh)

Since the carbon dioxide emission factor determined in section B4 has been fixed ex-ante, this equation may be simplified to the following:

$$BE_y = EG_{BL,y} * 0.556 \quad \text{Equation 2}$$

Project emissions

CDM-SSC-PDD-FORM

Accordingly to the methodology AMS-I.D. version 17 para 20, *for most renewable energy activities, $PE_y = 0$. However, for the following categories of project activities, project emissions have to be considered following the procedure described in the most recent version of ACM002.*

- *Emissions related to the operation of geothermal power plants (e.g. non-condensable gases, electricity/fossil fuel consumption)*
- *Emissions from water reservoirs of hydro power plants*

The project activity is a hydro power plant and it has no reservoir, hence, does not result in any project emissions. Project emissions, therefore, are zero.

Leakage

The methodology in para 22 specifies

If the energy generating equipment is transferred from another activity, leakage is to be considered

No equipment transfer takes place thus no leakage is considered in the project activity.

Emission Reductions

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation 3}$$

Where:

ER_y	Emissions reductions in year y, (t CO ₂ /y)
BE_y	Baseline Emissions in year y, (t CO ₂ /y)
PE_y	Project emissions in year y, (t CO ₂ /y)
LE_y	Leakage emissions in year y, (t CO ₂ /y)

Since project emission and leakage values are zero, the above equation reduces to:

$$ER_y = BE_y \quad \text{Equation 4}$$

Substituting the value of BE_y from equation 2 emission reductions value becomes:

$$ER_y = EG_{BL,y} * 0.556 \quad \text{Equation 5}$$

B.6.2. Data and parameters fixed ex ante

Data / Parameter	EF_{grid,OM}
Unit	tCO ₂ /MWh
Description	Simple Operating Margin
Source of data	All data used to calculate the emissions factor is publically available and detailed in Appendix 4. Data for electricity production and fuel use of power plant in the Thailand Grid is available from the Thailand Department of Alternative Energy Development and Efficiency(DEDE) for the years 2006, 2007 and 2008. Additional information for Small Power Producer (SPP) plants is available from the Thailand Energy Policy and Planning Office, Ministry of Energy.
Value(s) applied	0.543

CDM-SSC-PDD-FORM

Choice of data or Measurement methods and procedures	For full details of the choice of data and methods applied refer to Appendix 4.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter has been fixed ex-ante for the crediting period

Data / Parameter	EF_{grid,BM}
Unit	tCO ₂ /MWh
Description	Build Margin
Source of data	All data used to calculate the emissions factor is publically available and detailed in Appendix 4. Data for electricity production and fuel use of power plant in the Thailand Grid is available from the Thailand Department of Alternative Energy Development and Efficiency (DEDE) for the years 2006, 2007 and 2008. Additional information for Small Power Producer (SPP) plants is available from the Thailand Energy Policy and Planning Office, Ministry of Energy.
Value(s) applied	0.569
Choice of data or Measurement methods and procedures	For full details of the choice of data and methods applied refer to Appendix 4.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter has been fixed ex-ante for the crediting period

Data / Parameter	EF_{grid,CM}
Unit	tCO ₂ /MWh
Description	Carbon emissions factor for the Thailand grid
Source of data	All data used to calculate the emissions factor is publically available and detailed in Appendix 4. Data for electricity production and fuel use of power plant in the Thailand Grid is available from the Thailand Department of Alternative Energy Development and Efficiency(DEDE) for the years 2006,2007 and 2008. Additional information for Small Power Producer (SPP) plants is available from the Thailand Energy Policy and Planning Office, Ministry of Energy.
Value(s) applied	0.556
Choice of data or Measurement methods and procedures	For full details of the choice of data and methods applied refer to Appendix 4.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter has been fixed ex-ante for the crediting period

B.6.3. Ex ante calculation of emission reductions

>> As mentioned in section B.6.1, project emission (PE_y) and Leakage (LE_y) are zero.

Baseline Emissions

The hydro power plant is expected to operate for 365 days a year at a plant load factor of 58.78% generating 63,849 MWh of power. Substituting the below values in equation 5 from section B.6.1, the emission reductions achievable by the project activity are 34,967 tCO₂/MWh.

Table 6

S. No.	Parameter	Unit	Value
--------	-----------	------	-------

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CDM-SSC-PDD-FORM

1	Plant capacity	MW	12.4
2	Operating days	Days	365
3	Operating hours	Hours	24
4	Plant Load Factor	%	58.78
5	Gross generation	MWh	63,849
6	Auxiliary consumption	%	1.5%
7	Net generation available for export	MWh	62,891
8	Electricity Import	MWh	0
9	Grid emission factor	tCO ₂ /MWh	0.556
10	CER	tCO ₂	34,967

$$ER_y = EG_{BL,y} * 0.556$$

EG_{BL,y} is calculated as (EG_{export,y} – EG_{import,y}).

The amount of the electricity delivered to the Grid from the proposed project activity (EG_{export, y}) is expected to be 62,891 MWh per year. The electricity imported (EG_{import, y}) from the Grid to the proposed project activity is expected to be 0.

Thus,

$$BE_y = EG_{BL,y} \times EF_{CO_2,grid,y} = (EG_{export,y} - EG_{import,y}) \times EF_{CO_2,grid,y} \\ = (62,891 - 0) \times 0.556 = 34,967 \text{ tCO}_2\text{e.}$$

$$ER_y = 34,967 \text{ tCO}_2$$

According to above description, the net grid-connected electricity is equal to deducting the power consumption and line loss from average annual electricity generation which is calculated under an ideal condition, but in fact, the net grid-connected electricity is affected by many factors, such as power dispatching, equipments maintenance, water flow etc., as a result, the actual net grid-connected electricity and emission reduction may be different with that estimated in the PDD.

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

Year	Baseline emissions (t CO ₂ e)	Project emissions (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions (t CO ₂ e)
01 Jan 2013-31 Dec 2013	34,967	0	-	34,967
01 Jan 2014-31 Dec 2014	34,967	0	-	34,967
01 Jan 2015-31 Dec 2015	34,967	0	-	34,967
01 Jan 2016-31 Dec 2016	34,967	0	-	34,967
01 Jan 2017-31 Dec 2017	34,967	0	-	34,967
01 Jan 2018-31 Dec 2018	34,967	0	-	34,967
01 Jan 2019-31 Dec 2019	34,967	0	-	34,967
Total	244,769	0	-	244,769
Total number of crediting years	7			
Annual average over the crediting period	34,967	0	-	34,967

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

In order to calculate emission of baseline, we need to monitor the electricity supplied to the grid ($EG_{\text{export},y}$) and the electricity purchased from the grid ($EG_{\text{import},y}$) for the project activity, and from these two data, the net grid-connected electricity generation ($EG_{\text{BL},y}$) will be calculated ($EG_{\text{BL},y} = EG_{\text{export},y} - EG_{\text{import},y}$).

Data / Parameter	$EG_{\text{export},y}$
Unit	MWh/yr
Description	Power supplied by the project activity to the grid in year y
Source of data	<u>Measured value from electricity meter.</u>
Value(s) applied	62,891
Measurement methods and procedures	<u>Measured continuously by using electricity meter (class 0.2S). There are two main electricity meters for two generators installed inside EGAT's control room. Consolidated readings are recorded in monthly basis.</u>
Monitoring frequency	Measured continuously by using on-site electricity meter.
QA/QC procedures	<u>The reading data from the electricity meters are recorded in the reading export meter report by EGAT officer. Then these data shall be verified by off-taker party (PEA officer). The verified data shall be countersigned by PEA and EGAT officer. In case of main meter failure, the data from back up meter will be applied in such period.</u> The energy meter will be calibrated at least once in two year subject to national standards.
Purpose of data	Calculation of baseline emissions
Additional comment	All data will be kept for a minimum of 2 years following issuance of certified emission reductions or the end of the crediting period, whichever is later.

Data / Parameter	$EG_{\text{import},y}$
Unit	MWh/yr
Description	Power purchased by the project activity from the Grid in year y
Source of data	<u>Measured value from electricity meter.</u>
Value(s) applied	According to the actual records
Measurement methods and procedures	<u>Measured continuously by using electricity meter (class 0.2S). There are two electricity meters for two generators installed inside EGAT's control room. Consolidated readings are recorded in monthly basis.</u>
Monitoring frequency	Measured continuously by using on-site electricity meter.
QA/QC procedures	<u>Data measured by meters and recorded in the monthly report, will be cross checked against electricity invoice sent by PEA for electricity import. In case of main meter failure, the data from back up meter will be applied in such period.</u> <u>The energy meter will be calibrated at least once in two years subject to national standards.</u>
Purpose of data	Calculation of baseline emissions
Additional comment	All data will be kept for a minimum of 2 years following issuance of certified emission reductions or the end of the crediting period, whichever is later.

Data / Parameter	$EG_{\text{BL},y}$
Unit	MWh/yr
Description	Net electricity exported by the project activity in year y

Deleted: Energy meter readings from plant records

Deleted: (Type code: ZMD 402 CT44 - LANDIS + GYR) with Automated meter reading

Deleted: The reading data from the electricity meters are recorded and counterpart signed by PEA and EGAT. This monthly record is considered as official electricity sale document

Deleted: These meters

Deleted: are two-way meter through which export and import data will be continuously monitored. These data will be printed and recorded on a monthly basis. Additionally, two back up meters will also be installed for each generator. ¶

Moreover, a logbook will be maintained on site to record hourly readings from the energy meter. The readings will be taken by the shift supervisor. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager.

Deleted: ., record hourly.

Deleted: Data measured by meters and recorded in logbook will be cross checked by electricity sales receipt. This will act as a check against the electricity export-import meter readings. ¶

Deleted: Energy meter readings from plant records

Deleted: at entrance of the plant

Deleted: These monthly records are asconsidered as import electricity invoice by PEA.

Deleted: There are two meters for two generators (Type code: ZMD 402 CT44 - LANDIS + GYR) with Automated meter reading installed inside EGAT's control room. These meters are two-way meter through which export and import data will be continuously monitored. These data will be printed and recorded on a monthly basis. Additionally, two back up meters will also be installed for each generator. ¶

Moreover, a logbook will be maintained on site to record hourly readings from the energy meter. The readings will be taken by the shift supervisor. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager.

Deleted: , record hourly.

Deleted: As the electricity meters are belonging to PEA, therefore the meters will be calibrated according to PEA's regulation.

Deleted: logbook

Deleted: The electricity import data shall be verified by PEA and send to EGAT as the electricity import invoice. PEA for electricity import. ¶

CDM-SSC-PDD-FORM

Source of data	Energy meter readings from plant records
Value(s) applied	62,891
Measurement methods and procedures	EG_{BL,y} will be calculated by taking readings from both meters installed in the Control room. EG _{BL,y} is calculated as (EG _{export,y} – EG _{import,y}). EG _{export,y} and EG _{import,y} will be monitored continuously by the meter. This reading (export-import) will act as the basis for calculation of emission reductions.
Monitoring frequency	Continuously by the meter
QA/QC procedures	<u>The meters will be calibrated as described in parameter EG_{export,y} and EG_{import,y}</u>
Purpose of data	Calculation of baseline emissions
Additional comment	All data will be kept for a minimum of 2 years following issuance of certified emission reductions or the end of the crediting period, whichever is later.

Deleted: This can be cross checked against the electricity invoices. The energy meter will be calibrated at least once in two years subject to national standards.

Deleted: Details of the data to be monitored

Deleted: Section B.7.1 describes the data and parameters to be monitored. Monitoring shall consist of metering the export and import of electricity in the project activity. An internal audit will be carried out every year to ensure parameters are being monitored in accordance with the project PDD. ¶

Monitoring Procedure ¶

¶
EGAT is well aware of the importance of having a good operational and management team in order to execute a well-defined monitoring plan for the project activity. So, it has an operational and management structure created exclusively for monitoring data. The responsibilities of data monitoring, archiving and analyzing will fall on different members of the monitoring team. This team will be composed of head office, power plant manager and shift supervisor. The shift supervisor will record the monitoring data. The power plant manager will cross-check the monitoring data and system to be properly functional and the head office will analyze the power plant performance through the monitoring data. ¶

There will be three 8 hour shifts and the readings from energy meters will be taken on an hourly basis by the shift supervisor and recorded in logbooks. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager. The power plant manager will analyze the data every month and report to the head office. The data will be archived electronically every month and invoices of electricity sales will be maintained. ¶

¶
The suppliers of the equipments will train the staff in- charge during erection, to operate and maintain the equipments efficiently. Apart from this, the equipment supplier will provide complete manuals and documentation providing details for the maintenance schedule and the required activities associated with it. ¶

¶
The monitored data will be reported through EGAT to its head office on a monthly basis for the calculation and estimation of emission reductions. This data will be checked against initial estimates and a summary report will be provided quarterly. If the project is not performing as expected or if there are any negative impacts on the volume of emission reductions obtained, on the basis of the monthly data being monitored, a report will be sent to the project activity outlining where the project is deviating in its generation of emission reductions and the immediate measures which need to be undertaken to maintain the expected generation of emission reductions from the operation of this project. ¶

¶
At the end of each year of operation, a monitoring report will be prepared that will be submitted to a DOE for verification. All data will be kept for a minimum of 2 years following issuance of certified emission reductions or the end of the crediting period, whichever is later. ¶

Deleted: N/A

B.7.2. Sampling plan

>>

All values of data and parameters to be monitored are not determined by sampling approach

B.7.3. Other elements of monitoring plan

>>

Section B.7.1 describes the data and parameters to be monitored. Monitoring shall consist of metering the export and import of electricity in the project activity. An internal audit will be carried out every year to ensure parameters are being monitored in accordance with the project PDD.

Monitoring Procedure

EGAT is well aware of the importance of having a good operational and management team in order to execute a well-defined monitoring plan for the project activity. So, it has an operational and management structure created exclusively for monitoring data. The responsibilities of data monitoring, archiving and analyzing will fall on different members of the monitoring team. This team will be composed of head office, power plant manager and shift supervisor. The shift supervisor will record the monitoring data. The power plant manager will cross-check the monitoring data and system to be properly functional and the head office will analyze the power plant performance through the monitoring data.

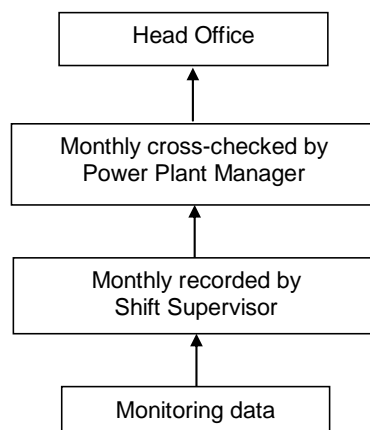


Figure 4 Data flow diagram

The suppliers of the equipments will train the staff in- charge during erection, to operate and maintain the equipments efficiently. Apart from this, the equipment supplier will provide complete manuals and documentation providing details for the maintenance schedule and the required activities associated with it.

The monitored data will be reported through EGAT to its head office on a monthly basis for the calculation and estimation of emission reductions. If the project is not performing as expected or if there are any negative impacts on the volume of emission reductions obtained, on the basis of the monthly data being monitored, a report will be sent to the project activity outlining where the project is deviating in its generation of emission reductions and the immediate measures which need to be undertaken to maintain the expected generation of emission reductions from the operation of this project.

Deleted: This data will be checked against initial estimates and a summary report will be provided quarterly.

At the end of each year of operation, a monitoring report will be prepared that will be submitted to a DOE for verification. All data will be kept for a minimum of 2 years following issuance of certified emission reductions or the end of the crediting period, whichever is later, and the storage of this data will be the responsibility of the project developers.

Emergency procedure

In case of emergency that the monitoring equipment has a problem, the shift supervisor/plant manager will inform and request EGAT head office to repair or replace as applicable the meter soonest and then inform PEA to verified the repaired/new meter. During emergency situation, monitoring data from backup meter will be used for calculation of emission reduction. In case loss of monitoring data from both main and backup meters at the same time, the emission reduction will not be claimed during this period.

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

>> 14/12/2009
Varsha Tripathi,
Senior Consultant
Agrinergy Pte Ltd.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> 12/03/2008 (signing of the EPC contract)

C.1.2. Expected operational lifetime of project activity

>> 30 years and 0 month

C.2. Crediting period of project activity**C.2.1. Type of crediting period**

>> A seven year renewable crediting period has been chosen.

This is the first crediting period.

C.2.2. Start date of crediting period

>> 01/01/2013 or on the date of registration of the CDM project activity, whichever is later.

C.2.3. Length of crediting period

>> 7 years 00 months.

SECTION D. Environmental impacts**D.1. Analysis of environmental impacts**

>> The implementation of the proposed hydro project has positive environmental impacts both globally and locally. In the global terms the positive impacts are outline as below:

1. A reduction in carbon dioxide emissions from the replacement of fossil fuels which would be generated under the baseline scenario.
2. A reduction in the emissions of other harmful gases (NO_x and SO_x) that arise from the combustion of coal in power generation.
3. No ash is generated in comparison to the baseline scenario.

The Local benefits to the environment as a result of the project activity can be summarised as follows:

Since hydro power generation is renewable and zero emission, no negative environmental impacts are expected with relation to the project activity in the local area surrounding the power plant.

The environmental impacts of the hydro project are minimal. Under MONRE rules an EIA is not required by the project activity. However, the Thailand DNA requires that an Initial Environmental Evaluation (IEE) be completed which includes an assessment of the project's environmental protection and improvement. The IEE has been completed and submitted to the Thai DNA.

SECTION E. Local stakeholder consultation**E.1. Solicitation of comments from local stakeholders**

>> For the project activity the local stakeholders have been consulted for the hydro power plant through local meetings in the surrounding areas. The details of these meetings are shown in the following table.

CDM-SSC-PDD-FORM

Date	Activities
30-Jan-08	Meeting with local leaders , heads of Tambon and villages and Or Bor Tor Bangluang, Amphoe Sapphaya
05-Feb-08	Meeting with local and village leaders Amphoe Sapphaya
07-Feb-08	Meeting with representatives of related government agencies in Chai Nat Province
11-Feb-08	Meeting in collaboration with OrBorTor Bangluang with villages from Moo 4 village
12-Feb-08	Meeting with villagers in Moo 5 ,Or Bor Tor Bangluang
10-Mar-08	Meeting with villagers in Moo 5 and Moo 12 Or Bor Tor Taluk
04-Feb-09	A notice published on newspaper to highlight the CDM aspects of the project
19-Feb-09	Organised a site visit for members of Tambon Bangluang Municipality, Amphoe Sapphaya, Chinat Province to observe the operations at Mae Somboonchon Hydropower Project at Amphoe Mae Tang, Chingmai Province. At the visit the CDM project was discussed and benefits of hydro project was highlighted.
20-Feb-09	Conducted a site visit for executives and members of Tambon Bangluang Municipality, Amphoe Sapphaya , Chai Nat Province at Mae Moh Lignite Mine Museum, Lampang Province. During the meeting the CDM aspect of the project was discussed. The participants also gained knowledge on pollution control and environmental protection measures implemented by EGAT.
29-Jun-09	Meeting at Or Bor Tor Tambon Bangluang's meeting room with local representative
30-Jun-09	Meeting at Or Bor Tor Tambon Ta Look's meeting room with local representative

Invitation letters were sent to local communities' representatives including villagers in project activity's area. After recipients acknowledged the invitations, the letters of acceptance from local representative's board had officially been introduced to EGAT stating local meeting hall's availability as well as an appropriate date and time. Afterward, EGAT had organized the meeting shown in the follow details for meetings' agenda. Information on project activity details were presented to attendees by local public coordinator, expert engineers and EGAT staffs. This meeting had been conducted with clear and transparent manner, at the last session of the meeting was reserved for question and answer in order to share their point of views as well as to fully understand the project activity.

Agenda of Stakeholders' Meeting 29th June 2009 and 30th June 2009

Session	Topics & Descriptions
1	Introduction to electricity generation of hydro power Plant <ul style="list-style-type: none"> - Amount of water will be use in the process - Quality & quantity of water after process used - Equipments installation's irrelevance to building a new dam
2	Points on advantages of project activity <ul style="list-style-type: none"> - Produce clean energy - Resolve electricity shortage - Replace imported fuel - Raise local developments - Support jobs availability in local area
3	Summarize & stakeholders' satisfaction
4	Question & Answer

First, 29th June 2009 meeting was held at Bangluang sub-district representative meeting hall, Supphaya district, Chainat province with 17 attendees.

List of Attendees in Stakeholders' Meeting 29th June 2009

Attendees	No. of Attendee
Government & State-owned Enterprise staff	3
Local communities' representatives	9
Farmers	3

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Merchant	1
Labourer	1
Total	17



Figure 3 Stakeholders' meeting 29th June 2009

Second, 30th June 2009 meeting was held at Ta Look sub-district representative meeting hall, Supphaya district, Chainat province with 17 attendees.

List of Attendees in Stakeholders' Meeting 30th June 2009

Attendees	No. of Attendee
Government & State-owned Enterprise staff	11
Local communities' representatives	1
Village leaders	3
Merchant	1
Other	1
Total	17



Figure 4 Stakeholders' meeting 30th June 2009

Moreover a notice in a newspaper on 4th Feb 2009 has been published to highlight the CDM aspects of the project.

E.2. Summary of comments received

>> The stakeholders' comments and responses were measured through the questionnaire after the meeting had ended. The measurement has been completed statistically under satisfaction points method.

Using criteria index of agreement upon mentioned items in agenda:

4 = Excellent 3 = Good 2 = Fair 1 = To be improved

After the resulted had been calculated, the end result showed 80% satisfaction (3.20 of 4.0) which implies excellent, which means no negative comments had been mentioned.

Stakeholders' comments and suggestions

Comments
1) Suggest EGAT should be concerned to sustainably develop Chao Phraya banks, suggest EGAT to cooperate with governor of local municipal on a campaign.
2) Suggest EGAT should make announcement through education centre within 1 km distance.
3) Suggest EGAT should form a committee in order to take care of any issue which might appear.
4) Suggest EGAT to develop the project activity's site to educational-tourism centre
5) Suggest EGAT should invite local people & students to observe and visit the project activity site.

Comments and suggestions have been brought to board meeting and relevant departments in order to find the most effective solution.

E.3. Report on consideration of comments received

>> There were no negative comments received in the stakeholder consultation and the local people welcomed the implementation of the project activity. Public consultation report has now been provided to the DOE.

SECTION F. Approval and authorization

>> The letter of approval from Thailand (Host country) for the project activity is available at the time of submitting the PDD to the validating DOE.

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Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input type="checkbox"/> Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Electricity Generating Authority of Thailand
Street/P.O. Box	53 Moo 2, Charansanitwong Road
Building	
City	Bang Kruai, Nonthaburi
State/Region	
Postcode	11130
Country	Thailand
Telephone	+66-2-4361140
Fax	+66-2-4361190
E-mail	waraporn.k@egat.co.th
Website	
Contact person	Ms. Waraporn Kunawanakit
Title	▼
Salutation	Ms
Last name	Kunawanakit
Middle name	
First name	Waraporn
Department	
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Deleted: +66-2-4361000

Deleted: +66-2-4361090

Deleted: sompop.p@egat.co.th

Deleted: Director, Environmental Division

Deleted: Mr

Deleted: Phuangjit

Deleted: Sompop

Appendix 2. Affirmation regarding public funding

The proposed project do not available any public funding from Annex I countries.

Appendix 3. Applicability of methodology and standardized baseline

Referring to Section B.2 of PDD, the applicability criteria are met for the project activity.

List of support documents for project activity eligibility:

1. Energy control generation license issued by the Energy Regulatory Commission

This document is used to confirm issues as listed below;

- The project activity can generate and export electricity to the grid (Applicability criteria 1)
- The project activity generates the electricity from hydro power (Applicability criteria 1, 4 and 6)
- The project activity is a Greenfield project (Applicability criteria 2, 7 and 8)
- The project activity is not involved to the volume of the reservoir (Applicability criteria 3)
- The project activity has two units of turbine & generator at capacity of 7,294 kVA (or 6,200 kW) which is less than 15 MW (Applicability criteria 5)

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

Calculation of Thai Grid Emission Factor

As per the guidance given in the methodology, if the project activity is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the following:

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

According to the methodology, the estimation is based on the calculation of - A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in “Tool to calculate the emission factor for an electricity system”¹⁶.

In line with the tool, six steps outlined for the determination of the emission factor has been followed.

- 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. Calculate the build margin (BM) emission factor.
- STEP 6. Calculate the combined margin (CM) emissions factor.

Step 1: Identify the relevant electric power system

For the purposes of defining the project electricity system, as the DNA has not published a delineation of the grid, Thailand national electricity grid is identified as the system boundary since there is only one grid electricity system in Thailand. For the purpose of determining the operating margin emission factor, the option of 0 tCO₂/MWh for net electricity imports from a connected electricity system will be chosen.

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

According to the tool, project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.

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

Option I is chosen to use in this calculation.

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

According to the *Tool to calculate the emission factor for an electricity system (version.02.2.1)*, the calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

¹⁶ [EB 63, Annex 19, Tool to calculate the emission factor for an electricity system, Version 2.2.1](#)

- (a) Simple OM, or
- (b) Simple adjusted OM, or
- (c) Dispatch data analysis OM, or
- (d) Average OM

The determination of the operating margin emission factor ($EF_{grid,OM,y}$) is based on the Simple OM method (option a).

- (a) The simple OM method is considered over other methods of calculating the operating margin because of dearth of relevant data as required by other methods.
- (b) Simple adjusted OM: Because of commercialization of social development, grid data became more and more private of National power groups for business reason in Thailand. So the basic data of annual grid dispatch curve is hardly available neither regionally nor provincially, therefore option (b) cannot be used in this proposed project.
- (c) Dispatch Data Analysis OM: Dispatch data analysis should be first methodological choice because it is the most conservative and accurate method to calculate Operation margin. However, in reality, it is very difficult to get concrete grid data of dispatch system. Therefore this option cannot be chosen.
- (d) Average OM: The average emission rate method (d) can only be used where low-cost/ must run resources constitute more than 50% of total grid generation. Therefore option (d) is not selected.

The simple OM method (option a) can be applied as low-cost/must-run (LCMR) resources constitute less than 50% of total grid generation in; 1) average of five most recent years, or 2) based on long-term averages for hydroelectricity production. Table below presents the national grid generation by sources in Thailand for the 2004-2008 period (five most recent years for which data is available) and LCMR constitutes less than 50% of total grid generation:

Description	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
LCMR (GWh)	6,042	5,800	8,128	8,117	7,118
Total power generation (GWh)	112,213	118,495	125,011	128,819	132,781
% LCMR	5%	5%	7%	6%	5%
5-year average					5.69%

Low-cost/must-run resources represents only 5.69% of total grid emission in Thailand, hence the simple OM method can be applied.

We have chosen to apply the ex-ante option: a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

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

The simple OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low cost / must-run power plants / units. The two options for calculating the simple OM are assessed as follows:

- Option A: Based on the net electricity generation and a CO₂ emission factor of each power unit; or
- Option B: Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

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This option is used for the calculation of simple OM because the necessary data is available.

Using Option B, the simple OM is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y})}{EG_y}$$

Equation 7

Where:

- $EF_{grid,OMsimple,y}$ Simple operating margin CO₂ emission factor in year y (tCO₂/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)
 $EF_{CO_2,i,y}$ CO₂ emission factor of fossil fuel type i in year y (tCO₂/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

Classification	Fuel Type	Year 2006		Year 2007		Year 2008		Unit of Fuel Consumption
		Power Generation (GWh)	Fuel Consumption	Power Generation (GWh)	Fuel Consumption	Power Generation (GWh)	Fuel Consumption	
Non - LCMR	Natural Gas	86,339	764,215	88,166	783,137	94,549	812,620	MMscf
	Fuel Oil	8,350	2,030	3,646	936	1,454	350	million litres
	Diesel Oil	143	41	174	23	180	44	million litres
	Lignite		15,816		15,811		16,408	1000 tons
	Imported Coal	22,051	-	28,716	3,839	29,480	4,057	1000 tons
SPP and VSPP	Natural Gas		92,888		94,725		94,707	MMscf
	Fuel Oil		8.17		6.98		7.55	million litres
	Diesel Oil	13,731	0.44	14,559	1.25	14,646	1.45	million litres
	Lignite		9		893		-	1000 tons
	Imported Coal		1,341		6		970	1000 tons
Import	Hydro	5,152	-	4,488	-	2,784	-	-
LCMR	Hydro	8,125	-	8,114	-	7,113	-	-
	Renewable Energy	3	-	3	-	5	-	-
Total Non - LCMR + Import (including)		135,766		139,749		143,093		

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SPP & VSP)							
Total Power Generation	143,894		147,866		150,211		

Type of Fuel	Unit of Fuel	NCV (TJ/unit)	EF _{CO₂} (tCO ₂ /TJ)	Source
Natural Gas	MMscf	1.02	54.30	Net calorific value (NCV) and CO ₂ emission factor (EFCO ₂) of each fossil fuel type has been obtained from "Electric Power in Thailand 2008" (source: DEDE, page 42) and IPCC 2006 Guideline (Volume 2: Energy, Table 1.4), respectively
Fuel Oil	million litres	39.77	75.50	
Diesel Oil	million litres	36.42	72.60	
Lignite	1000 tons	10.47	90.90	
Imported Coal	1000 tons	26.37	89.50	

Total CO₂ emissions from fossil fuel consumption in yearly power generation are calculated in below table:

Type of Fuel	Unit of Fuel	Fuel Consumption (TJ)			CO ₂ Emissions (tCO ₂)		
		Year 2006	Year 2007	Year 2008	Year 2006	Year 2007	Year 2008
Natural Gas	MMscf	874,245	895,419	925,474	47,471,507	48,621,265	50,253,213
Fuel Oil	million liters	81,058	37,502	14,220	6,119,881	2,831,410	1,073,586
Diesel Oil	million liters	1,509	883	1,655	109,561	64,114	120,171
Lignite	1000 tons	165,688	174,891	171,792	15,061,016	15,897,581	15,615,871
Imported Coal	1000 tons	35,362	101,393	132,562	3,164,914	9,074,642	11,864,298

Simple operating margin CO₂ emission factor will be calculated as per equation (6)

Description	Year 2006	Year 2007	Year 2008	Unit
Total CO ₂ emissions	71,926,879	76,489,012	78,927,140	tCO ₂
Total Non - LCMR + Import	135,766,000	139,749,000	143,093,000	MWh
Simple OM emission factor	0.530	0.547	0.552	tCO ₂ /MWh
3-year average simple OM emission factor	0.543			tCO₂/MWh

Hence, EF_{grid,OM,y} = 0.543 tCO₂/MWh

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

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

Option 1: For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of crediting period to the DOE. For the

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third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

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

The Option 1 will be chosen for calculation of the build margin (BM) emission factor.

The sample group of power units m used to calculate the build margin will be determined as per the following procedure, consistent with the data vintage selected above:

- (a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5-units}$) and determine their annual electricity generation ($AEG_{SET_{5-units}}$ in MWh);
- (b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise of 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET_{\geq 20\%}}$ in MWh);
- (c) From $SET_{5-units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

Otherwise:

- (d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises of 20% the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET_{sample-CDM}}$ in MWh);

If the annual electricity generation of that set is comprised at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET_{sample-CDM}} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

- (e) Included in the sample group $SET_{sample-CDM}$ the power units that started to supply the electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);
- (f) The sample of power units m used to calculate the build margin is the resulting set ($SET_{sample-CDM > 10 \text{ yrs}}$)

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Sub-step to identify sample group of power units m .

- (a) The set of five power units, excluding power units registered as CDM project activity that started to supply electricity to the grid most recently

Plant Name	Commissioning Date	Fuel Type	Installed Capacity in 2008 (MW)	Generation in 2008 (MWh) ¹⁷
Chana Power, unit 3	15/07/2008	Natural gas	250	3,754,000
Chana Power, unit 2			230	
Chana Power, unit 1			230	
Ratchburi power, Unit 2	1/6/2008	Natural gas	700	5,812,000
Ratchburi power, Unit 1	1/3/2008		700	
Total Generation of most recently power units				9,566,000

For the set of 5 most recently built power units ($SET_{5-units}$), the annual electricity generation ($AEG_{SET5-units}$) is 9,566,000 MWh.

- (b) The set of power capacity additions that comprise 20% of the system generation, excluding power units registered as CDM project activity, in MWh that have been built most recently

Name of power plant	Plant type	Date of commissioning	Installed capacity in 2008 (MW)	Generation in 2008 ¹⁸ (MWh)
1 Chana power, unit 3	Natural gas	15/07/2008	250	3,754,000
2 Chana power, unit 2			230	
3 Chana power, unit 1			230	
4 Ratchaburi power, unit2	Natural gas	1/6/2008	700	5,812,000
5 Ratchaburi power, unit1		1/3/2008	700	
6 Gulf Power Generation Co., Ltd.	Natural gas	1/3/2008	1,468	9,195,000
7 BLCF Co., Ltd. unit2	Coal	14/11/2006	673.3	10,801,000
8 BLCF Co., Ltd. unit1		13/8/2006	673.3	
Total Generation of SET>20% (AEG _{SET>20%})				29,562,000
Total generation in 2008 (AEG _{total})				150,211,000
Total % grid contribution				20%

(c) From sub-step (a) and (b) above, it can be concluded that $AEG_{SET>20\%}$ is larger than $AEG_{SET5-units}$. So the power units in (b) is set of sample (SET_{sample}). In addition, none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years. Sub-step (d), (e), and (f) are ignored.

The *ex-ante* option (Option 1) is chosen in this calculation: BM is calculated according to the most recent data available on units already built for sample group m at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period.

The following equation is applied to determine the build margin emissions factor.

$$EF_{grid,BM,y} = \frac{\sum_{i,m} EG_{m,y} \times EF_{EF,m,y}}{\sum_m EG_{m,y}} \quad \text{Equation 8}$$

¹⁷ Table 8, Existing national grid power plant in 2008, electric power in Thailand 2008, DEDE

¹⁸ Table 8, Existing national grid power plant in 2008, electric power in Thailand 2008, DEDE

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Where:

$EF_{grid,BM,y}$ Build margin CO₂ emission factor in year y (tCO₂/MWh)

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

$EF_{EL,m,y}$ CO₂ emission factor of power unit m in year y (tCO₂/MWh)

m Power units included in the build margin

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

According to the most recent available data on generation and efficiency of the cohort of power units released by the DEDE:

Name of power plant	Plant type	Commissioning Date	Capacity (MW)	Generation (MWh)	Efficiency (Btu/kWh) ¹⁹	Effective CO ₂ emission Factor (tCO ₂ /MWh)	CO ₂ emission (tCO ₂)
1 Chana power, unit 3	Natural gas	15/07/2008	250	3,754,000	7,082	0.403	1,511,140
2 Chana power, unit 2			230				
3 Chana power, unit 1			230				
4 Ratchaburi power, unit2	Natural gas	1/6/2008	700	5,812,000	7,051	0.403	2,339,570
5 Ratchaburi power, unit1		1/3/2008	700				
6 Gulf Power Generation Co., Ltd.	Natural gas	1/3/2008	1,468	9,195,000	6,950	0.403	3,701,368
7 BLCP Co., Ltd. unit2	Coal	14/11/2006	673.3	10,801,000	9,100	0.859	9,280,170
8 BLCP Co., Ltd. unit1		13/8/2006	673.3				
	Total			29,562,000			16,832,248
$EF_{grid,BM,2008}$ (tCO ₂ /MWh)							0.569

The CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) is determined as per the guidance in step 4(a) for the simple OM, which using option A1 based on available data (data on fuel consumption and electricity generation from EGAT and Department of Alternative Energy Development and Efficiency (DEDE))

Hence, $EF_{grid,BM,y} = 0.569$ tCO₂/MWh

Step 6: Calculate the combined margin emissions factor.

The calculation of the combined margin emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

- Weighted average CM; or
- Simplified CM

The method (a) is chosen and the following equation is applied for the build margin emission factor calculation.

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \text{Equation: 9}$$

¹⁹ Table 18, Electric generation efficiency by types of power plants in 2008, electric power in Thailand 2008

Where:

$EF_{grid,OM,y}$	Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,BM,y}$	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
W_{OM}	Weighting of operating margin emissions factor (%)
W_{BM}	Weighting of build margin emissions factor (%)

Using default values set in the *Tool to calculate the emission factor for an electricity system Version 02.2.1*,

$$W_{OM} = W_{BM} = 50\%$$

Calculation of the combined margin

	tCO ₂ /MWh
Simple OM, $EF_{OM,y}$	0.543
Build margin $EF_{BM,y}$	0.569
Combined margin, EF_y	0.556

To conclude, the baseline emission factor is obtained from 50% weighted average of the operating margin (OM) and build margin (BM) emission factors. In calculating the OM emission factor, the Simple OM method is selected due to limited information available at the time. The OM emission factor is the generation weighted average emissions per electricity unit (tCO₂/MWh) of all generating sources serving the system, not including low-cost/must run power plants, on an average 3 most recent years where the data is accessible. The BM emission factor is calculated as the generation-weighted average emission factor (tCO₂/MWh) of a sample of power plants which comprise 20% of the system generation (in MWh) and that have been built most recently till 2008.

The result show that 3-year average OM emission factor of the years 2006 to 2008 is 0.543 and the BM emission factor of 2008 equals to 0.569. Therefore the baseline emission factor of the country's electricity system, on 50% weighted average of both emission factors, is 0.556tCO₂/MWh.

Appendix 5. Further background information on monitoring plan

Referring to section B.7 for details

Appendix 6. Summary of post registration changes

Summary of post registration changes is provided as following;

Deleted: Not applicable at the validation stage.

1. Description of "Purpose and general description of project activity (section A.1)

The description of the purpose and general description of project activity has been revised to reflect the "Instructions for filling out the project design document form for small-scale CDM project activities" of Project design document form for small-scale CDM project activities Version 06.0. Therefore this change was occurred during verification period

2. Correction on the specification of generator

There are two corrections on the rated capacity and rated power of generator's specification.

Generator	Specification in registered PDD	Corrections
Rated Capacity	6.2 MW	7.294 kVA
Rated Power	Not indicated	6.2 MW
Rated Voltage	6.600V	6.600V
Rated Frequency	50Hz	50Hz
Rated Speed	125 rpm	125 rpm
Rated power factor	0.85	0.85
Number of phases	3	3
Units	2	2

The above changes do not increase the installed capacity of the project activity or amount of generated electricity. As a result, these changes do not affect to the additionality or IRR calculation. These changes were occurred during validation stage.

3. Parameter EG_{export,y} in section B.7.1

Data	Registered monitoring plan	Permanent changed from registered monitoring plan
Source of data	Energy meter reading from plant records	Measured value from electricity meter
Measurement methods and procedures	There are two meters for two generators (Type code: ZMD 402 CT44 - LANDIS + GYR) with Automated meter reading installed inside EGAT's control room. These meters are two-way meter through which export and import data will be continuously monitored. These data will be printed and recorded on a monthly basis. Additionally, two back up meters will also be installed for each generator. Moreover, a logbook will be maintained on site to record hourly readings from the energy meter. The readings will be taken by the shift supervisor. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager.	Measured continuously by using electricity meter (class 0.2S). There are two main electricity meters for two generators installed inside EGAT's control room. Consolidated readings will be recorded in monthly basis.
QA/QC procedures	Data measured by meters and recorded in logbook will be cross checked by electricity sales receipt. This will act as a check against the electricity export-import meter readings. The energy meter will be calibrated at least once in two year subject to national standards.	The reading data from the electricity meters are recorded in the reading export meter report by EGAT officer. Then these data shall be verified by off-taker party (PEA officer). The verified data

Deleted: data

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		shall be countersigned by PEA and EGAT officer. In case of main meter failure, the data from back up meter will be applied in such period. The energy meter will be calibrated at least once in two year subject to national standards.
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Reasons for the above changes are listed below:

1. The monitoring procedure has been revised to reflect the actual monitoring practice.
2. In case the energy meter is malfunction/failure and need to be replaced, the same type or brand of the energy meter may not be available at that time as well as in case of calibration procedure, the meter will be removed and may be replaced by the new type of the meter. The accuracy class of the new or replacing meter will be the same as class 0.2S. Therefore the type and model of energy meter have been removed for flexibility.

These changes were occurred after the registration date (27/12/2012).

Deleted: <#>The monthly official electricity sale is used to represent as the quantity of "Power supplied by the project activity to the grid in year y" because this document is most credible record as it is verified and counterpart signed by officers from EGAT and PEA. ¶ The data in monthly official electricity sale is read from continuous monitoring (energy meter) which is complied to the applied methodology AMS-I.D version 17.

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4. Parameter $EG_{import,y}$ in section B.7.1

Data	Registered monitoring plan	Permanent changed from registered monitoring plan
Source of data	Energy meter reading from plant records	Measured value, from electricity meter
Measurement methods and procedures	There are two meters for two generators (Type code: ZMD 402 CT44 - LANDIS + GYR) with Automated meter reading installed inside EGAT's control room. These meters are two-way meter through which export and import data will be continuously monitored. These data will be printed and recorded on a monthly basis. Additionally, two back up meters will also be installed for each generator. Moreover, a logbook will be maintained on site to record hourly readings from the energy meter. The readings will be taken by the shift supervisor. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager.	Measured continuously by using electricity meter (class 0.2S). There are two electricity meters for two generators installed inside EGAT's control room. Consolidated readings are recorded in monthly basis.
QA/QC procedures	Data measured by meters and recorded in logbook will be cross checked against electricity invoice sent by PEA for electricity import. The energy meter will be calibrated at least once in two years subject to national standards.	Data measured by meters and recorded in the monthly report will be cross checked against electricity invoice sent by PEA for electricity import. In case of main meter failure, the data from back up meter will be applied in such period. The energy meter will be calibrated at least once in two years subject to national standards.

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Deleted: The electricity import data shall be verified by PEA and send to EGAT as the electricity import invoice.

Reasons for the above changes are listed below:

1. The monitoring procedure has been revised to reflect the actual monitoring practice.

CDM-SSC-PDD-FORM

2. In case the energy meter is malfunction/failure and need to be replaced, the same type or brand of the energy meter may not be available at that time as well as in case of calibration procedure, the meter will be removed and may be replaced by the new type of the meter. The accuracy class of the new or replacing meter will be the same as class 0.2S. Therefore the type and model of energy meter have been removed for flexibility.

These changes were occurred after the registration date (27/12/2012).

5. QA/QC procedures of parameter $EG_{BL,y}$

Data	As per registered PDD	Post registration change
QA/QC procedures to be applied	This can be cross checked against the electricity invoices. The energy meter will be calibrated at least once in two years subject to national standards	The meters will be calibrated as described in parameter $EG_{export,y}$ and $EG_{import,y}$

Reason for the above change

1. The value of $EG_{BL,y}$, could not be cross checked against the electricity invoices because there are two invoices for export and import electricity separately. No deducted electricity (Export electricity – Import electricity) invoice is available for cross-checking.

This change was occurred after the registration date (27/12/2012).

6. Monitoring Procedure in section B.7.2

Data	Registered monitoring plan	Permanent changed from registered monitoring plan
Monitoring Procedure and Emergency Procedure (B.7.3)	There will be three 8 hour shifts and the readings from energy meters will be taken on an hourly basis by the shift supervisor and recorded in logbooks. This hourly data will be signed off at the end of every shift by the engineer in charge of the shift and again at the end of each day by the power plant manager. The power plant manager will analyze the data every month and report to the head office. The data will be archived electronically every month and invoices of electricity sales will be maintained.	EGAT is well aware of the importance of having a good operational and management team in order to execute a well-defined monitoring plan for the project activity. So, it has an operational and management structure created exclusively for monitoring data. The responsibilities of data monitoring, archiving and analyzing will fall on different members of the monitoring team. This team will be composed of head office, power plant manager and shift supervisor. The shift supervisor will record the monitoring data. The power plant manager will cross-check the monitoring data and system to be properly functional and the head office will analyze the power plant performance through the monitoring data. Emergency procedure In case of emergency that the monitoring equipment has a problem, the shift supervisor/plant manager will inform and request EGAT head

Deleted: <#> The monthly official import electricity invoice is used to represent as the quantity of "Power purchased by the project activity from the Grid in year y" because this document is most credible record as it is a third party document (PEA). ¶
The data in monthly official electricity invoice is read from continuous monitoring (energy meter) which is complied to the applied methodology AMS-I.D version 17.

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CDM-SSC-PDD-FORM

		office to repair or replace as applicable the meter soonest and then inform PEA to verified the repaired/new meter. During emergency situation, monitoring data from backup meter will be used for calculation of emission reduction. In case loss of monitoring data from both main and backup meter at the same time, the emission reduction will not be claimed during this period.
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Reason for the above change:

The monitoring procedure has been changed to reflect the practical present monitoring procedure. These changes were occurred after the registration date (27/12/2012).

7. Expected operational lifetime of the project activity (Section C.1.2) and Type of crediting period (Section C.2.1)

Expected operational lifetime of the project activity (Section C.1.2) and Type of crediting period (Section C.2.1) have been revised as per the "Instructions for filling out the project design document form for small-scale CDM project activities" of Project design document form for small-scale CDM project activities Version 06.0. Therefore this change was occurred during verification period

8. Approval and authorization (Section F)

This section has been revised as the letter of approval from Thailand (Host country) for the project activity is available at the time of submitting the PDD to the validating DOE. Therefore this change was occurred during verification period

9. Contact information of project participants and responsible persons/ entities (Appendix 1)

The contact information of project participants and responsible persons/ entities has been revised as per the latest Modalities of Communication (MoC) available on UNFCCC CDM website. Therefore this change was occurred during verification period

10. Applicability of methodology and standardized baseline (Appendix 3)

List of document support to the applicability criteria in Section B.2 has been added as per the "Instructions for filling out the project design document form for small-scale CDM project activities" of Project design document form for small-scale CDM project activities Version 06.0. Therefore this change was occurred during verification period