CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28/07/2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Title: Song Bung 5 Hydropower Project

Version: 2.3

Date: 03/10/2011

A.2. Description of the project activity:

The Song Bung 5 hydropower project activity involves the construction of a two generating unit hydropower plant having installed capacity of 57MW. The main structures of the project include a dam, water intake, a power house, electricity distribution station etc. The project is located on Bung River in Ma Cooih commune, Dong Giang district and Thanh My town, Nam Giang district, Quang Nam province, Viet Nam.

Prior to the implementation of the project activity, electricity in Viet Nam is generated mainly from fossil fuel sources and is solely distributed to consumers via the unique national electricity grid.

The project's purpose is to generate hydroelectricity from Bung river, a clean and renewable source, to supply the national grid. The project's installed capacity and estimated annual gross power generation is 57 MW and 230,340 MWh[1], respectively. The net electricity generated (with an estimated annual volume of 226,884.9 MWh[2]) will be supplied to the national grid via a newly constructed transmission line (length of around 13 km) from the plant to a transformer station.

The baseline scenario of the project activity is the same as the scenario existing prior to the start of implementation of the project activity.

The project activity will generate renewable power with negligible Greenhouse Gas (GHG) emissions, which will displace part of the electricity otherwise supplied by fossil fuel fired power plants. The project involves construction of a reservoir with an area of 168 ha[3] and a power density of 33.9 W/m^2, accordingly. As the power density of this project is greater than 10 W/m^2, GHG emission reductions can be achieved via this proposed project activity. Total expected CO_2 emission reduction is 915,432 tCO_2 over the first crediting period of 7 years.

The project's contributions to the sustainable development of the local area as well as the host country are as follows:

General contributions towards national sustainable development:

- In recent years, Viet Nam has suffered a critical electricity shortage as a consequence of rapidly increasing demand and insufficient supply, thereby imposing negative impacts on economic growth as well as on the daily lives of people. This project activity will be a contribution towards balancing the supply and demand gap. By exporting electricity directly to the national grid, it will help improve the quality of service and lessen the risks of power failure.
- Reducing reliance on exhaustible fossil fuel based power sources and also reducing the import of fuels for the purpose of power generation.

[1] Feasibility Study Report
[2] The gross power generation subtracts 1.5% for parasitic and loss load.
[3] Feasibility Study Report

- Modern and highly efficient turbines and generators are being used in the project and the power transmission will be at high voltage to ensure low losses. The project will accelerate the deployment of renewable energy technologies in Viet Nam.

Contributions towards local sustainable development:

a) Economic well-being

Once commissioning, this proposed project will increase the industrial share in the economic structure of Quang Nam province. This proposed project will significantly contribute to the state budget via taxes i.e. annual enterprise revenue tax, natural resource tax[4] and CER tax[5].

By supplying a stable electricity output, this project will facilitate the industrialisation process of the province and leverage the performance of traditional trade villages as well as tourism industry and services inside the province.

After commissioning, this project will supply electricity to speed up the commissioning of other large infrastructure projects in the region.

b) Social well-being

The project improves existing roads, which will facilitate the transportation and travel. Thus, the project creates convenience for the transfer and trade in the area, thereby improves minorities' living standard and contribute to fill the gap in development between different ethnic groups in Viet Nam.

By supplying a stable electricity output, this project will facilitate the industrialisation process of the province and support economic development of local villages through fostering tourism, trade and services inside the province. This project will contribute directly to improve the low-quality infrastructure systems of the mountainous commune.

The project will construct a new transmission line together with the hydropower plant, which will reduce electricity losses and improve the quality of electricity supply in the region.

The communication system and clean water treatment serving for workers of the project during the both construction and operation phases will be shared with local people. Besides, the project activity could result in the employment of the local people for the construction and operation later. Therefore, this project activity will contribute directly to alleviate poverty in the region.

In conclusion the project activity will contribute positively towards sustainable development of Viet Nam.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants(*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Viet Nam (host)	Power Engineering Consulting Joint Stock Company 1 (private entity)	No
Viet Nam (host)	Energy and Environment Consultancy	No

[4] According to the Investment law and Natural resource law

[5] According to Circular No. 58/2008/TTLT-BTC-BTN&MT issued by Ministry of Finance and Ministry of Natural Resource and Environment on 04 July 2008

	Joint Stock Company (private entity)	
Switzerland	Vietnam Carbon Assets Ltd. (private entity)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Viet Nam

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

Quang Nam province

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

Ma Cooih commune, Dong Giang district and Thanh My town, Nam Giang district

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

The proposed project activity involves the construction of Song Bung 5 hydropower plant which is located on Bung River. This project has the following co-ordinates[6]:

Co-ordinates of dam:	$15^0$48'31.12''	Northern latitude
	$107^0$44'43.74''	Eastern longitude

The site of the project is showed in Figure 1.

[6] Feasibility Study Report

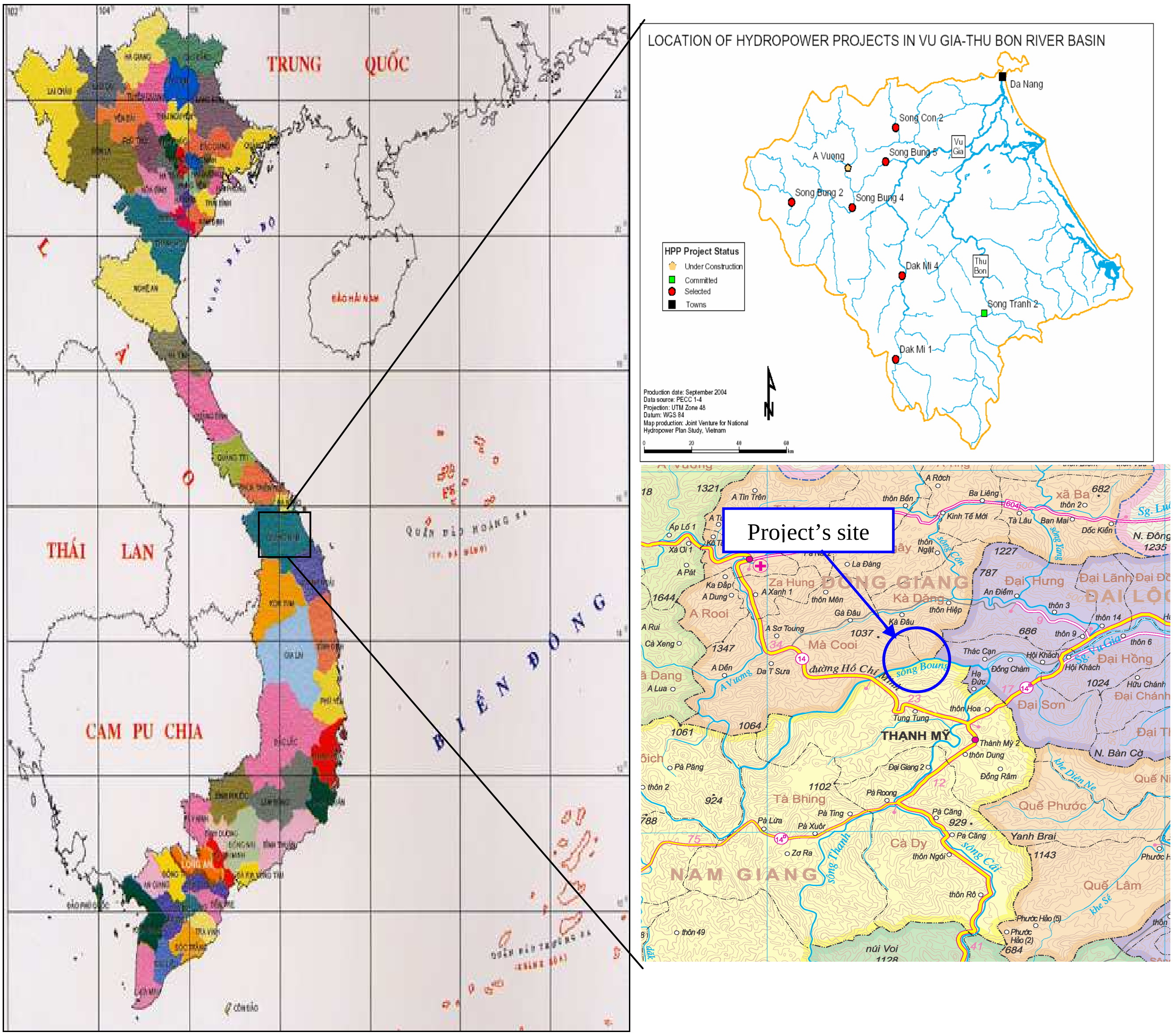

Figure 1: Map of the location of the project activity

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

Sectoral scope/ Category: 1: Energy industries (renewable sources)
Grid-connected electricity generation from renewable sources

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

Electricity in Viet Nam supplied to the national grid is generated by the operation of grid-connected power plants and mainly firing coal, oil or gas (for more information see Annex 3) and is solely distributed via the unique national electricity grid. All fuel fired power plants connected to the national grid use boiler rooms, steam heating boilers and steam turbines to generate electricity so GHG are emitted in this process. By contract hydro power generation is a renewable electricity generation technology which does not generates significant GHG emissions and displaces electricity supplied to the grid from fossil-fuel-fired power generation sources. Therefore the implementation of this project activity will generate emission reductions.

The project activity involves the construction of a dam, power house, electricity distribution station, etc. in order to convert potential flowing energy from Bung River into clean electrical energy, which will be supplied to the national grid through 110 kV transmission line. It also involves the construction of a reservoir with a power density of 33.9W/m^2, greater than the 10 W/m^2 threshold established in Version 12.2.0 of ACM0002. Accordingly, GHG emissions from the reservoir shall not be taken into account under this the project activity.

At the connection point, the power meter systems will be installed. They are digital and bi-directional type to measure the export and import electricity of Song Bung 5 hydropower plant.

Figure 2 shows the layout of the project.

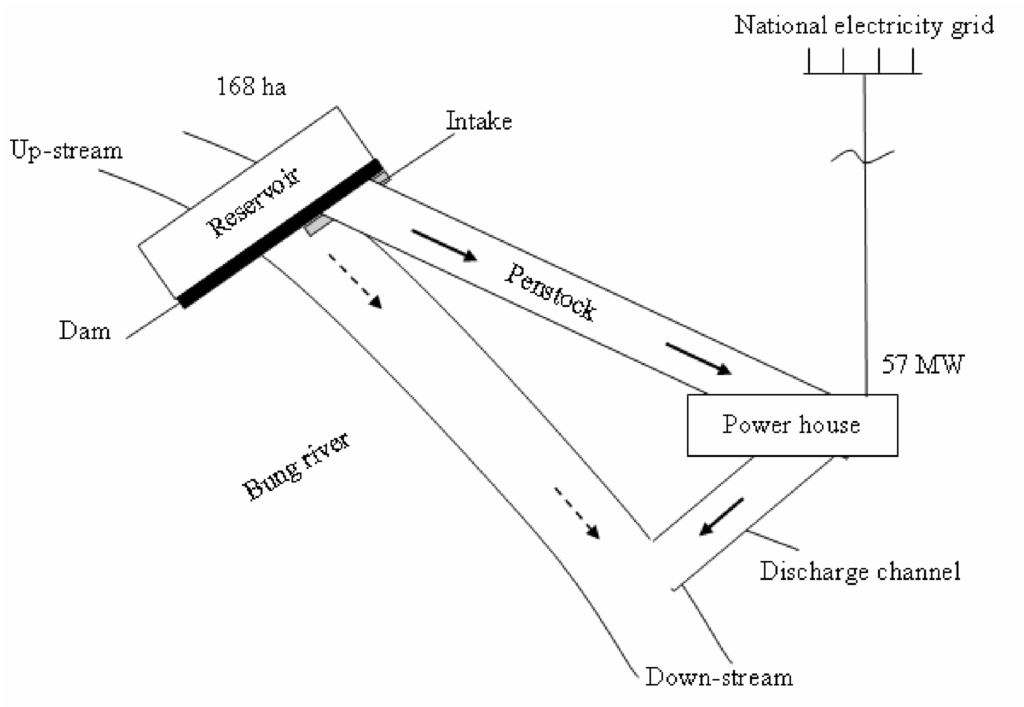

Figure 2: Song Bung 5 hydropower plant's lay-out

The main technical parameters of the Song Bung 5 Hydropower Project are shown in Table 1.

Table 1: Main technical parameters of the proposed project activity[7]

Main parameters	Units	Values
1. Turbine		
• Type		Kaplan, vertical shaft
• Rated net head	m	27.0
• Number of turbine	set	2
• Turbine discharge	m^3/s	119.62
• Rated capacity	MW	29.484
• Speed	rpm	187.5
• Expected lifetime[8]	hour	150,000
• Efficiency	%	93.1
2. Generator		
• Number	set	2
• Type		Synchronous, 3-phase, vertical shaft
• Rated voltage	kV	10.5
• Rated capacity	MW	28.5
• Expected lifetime[9]	year	25
• Efficiency	%	97
• Capacity coefficient cos φ		0.9
3. Transformer		
• Number	set	2
• Type		3 phases, 2 windings
• Voltage	kV	13.8/115kV ± 2x2.5%
• Expected lifetime[10]	year	30
4. Annual river flow[11]	m^3/s	118.13

The main equipment utilized in this project will be imported from China via Equipment Supply Contract[12] signed with Hydrochina Zhongman-Zhefu. All the turbines and alternators must be the state-of-art technology and met the criteria as mutually agreed i.e. ensuring environmental safety and sound

[7] Feasibility Study Report
[8] Default technical lifetime of the equipment, Annex 15 to EB 50 Report, page 4
[9] Default technical lifetime of the equipment, Annex 15 to EB 50 Report, page 4
[10] Default technical lifetime of the equipment, Annex 15 to EB 50 Report, page 4
[11] Feasibility Study Report
[12] Equipment Contract No.368/Hd-TVD1-P2 dated 19/08/2010

technology. The professional technicians and engineers will train the hydropower plant staffs on the monitoring procedures, operation regulation, maintenance procedures and other required knowledge regarding the hydropower plant before the start of operation of the project. Furthermore, there will be regular training courses regarding monitoring and operation for plant staffs during operation period. So the modern technology would be transferred to the host country.

The baseline scenario of this project activity is identical to the existing scenario mentioned above.

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

The project activity will achieve GHG emission reduction by displacing power generated by fossil fuel fired plants connected to the national grid. The project will apply for a seven-year crediting period, renewable twice up to a total of 21 years. The estimated emission reductions for the first crediting period are presented in Table 2.

Table 2: Emission reduction of the proposed project during the first crediting period

Year	Annual estimated emission reduction tCO_2 e
2012 (01/07/2012 – 31/12/2012)	65,388
2013	130,776
2014	130,776
2015	130,776
2016	130,776
2017	130,776
2018	130,776
2019 (01/01/2019 – 30/06/2019)	65,388
Total estimated reductions (tCO2e)	**915,432**
Total number of crediting years	**7**
Annual Average estimated reduction over the crediting period (tCO2e)	**130,776**

A.4.5. Public funding of the project activity:

No public funds or ODA from Annex I countries is involved in this project.

SECTION B. Application of a baseline and monitoring methodology

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

Applied methodology:

- Version 12.2.0 of ACM0002: “Consolidated baseline methodology for grid-connected electricity generation from renewable sources”

Related tools:

- Version 02.2.1 of the "Tool to calculate the emission factor for an electricity system"
- Version 06.0.0 of the "Tool for the demonstration and assessment of additionality"

The methodology and the related tools are available on the UNFCCC website:
http://cdm.unfccc.int/methodologies/DB/C505BVV9P8VSNNV3LTK1BP3OR24Y5L

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

This proposed project is a grid-connected hydroelectric generation plant, which falls under the scope of ACM0002 Version 12.2.0. More details of the comparison of the project's characteristics and the applicability criteria as specified in, Version 12.2.0 of ACM0002 is given in Table 3.

Table 3: Comparison of project's characteristics and eligibility criteria of Version 12.2.0 of ACM0002

Applicability conditions in Version 12.2.0 of ACM0002	Characteristics of the project activity	Applicability criterion met?
The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run of river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;	The project activity involves the installation of a new hydropower plant	Yes
In the case of the capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 10 to calculate the parameter $EG_{pJ,y}$): the existing plant started commercial operation prior to the start of a minimum historical reference period of the five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;	The project activity is to install a new hydro power plant	Not applicable
In case of hydro power plants: • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or • The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m^2; or	 The project activity is to create a new reservoir The project activity is to create a new reservoir	 Not applicable Not applicable

• The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project Emissions section, is greater than 4 W/m^2.	The project activity results in a new reservoir, with a power density of 33.9 W/m^2, which is greater than 4 W/m^2.	Yes
This methodology is not applicable to • Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of the fossil fuels at the site.	It is a renewable energy project with no fuel-switch involved.	Yes
• Biomass fired power plants.	The project activity is to install a new hydro power plant.	Yes
• Hydropower plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is less than 4 W/m^2.	The project activity results in a new reservoir, with a power density of 33.9 W/m^2, which is greater than 4 W/m^2.	Yes

This comparison shows clearly that the proposed project activity fulfils all applicability criteria to be eligible under Version 12.2.0 of ACM0002.

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

According to Version 12.2.0 of ACM0002, the spatial extent of the project boundary includes the Song Bung 5 hydro power plant and all power plants connected physically to the national electricity grid to which the proposed project is also connected.

The flow diagram of the project boundary is shown in Figure 3.

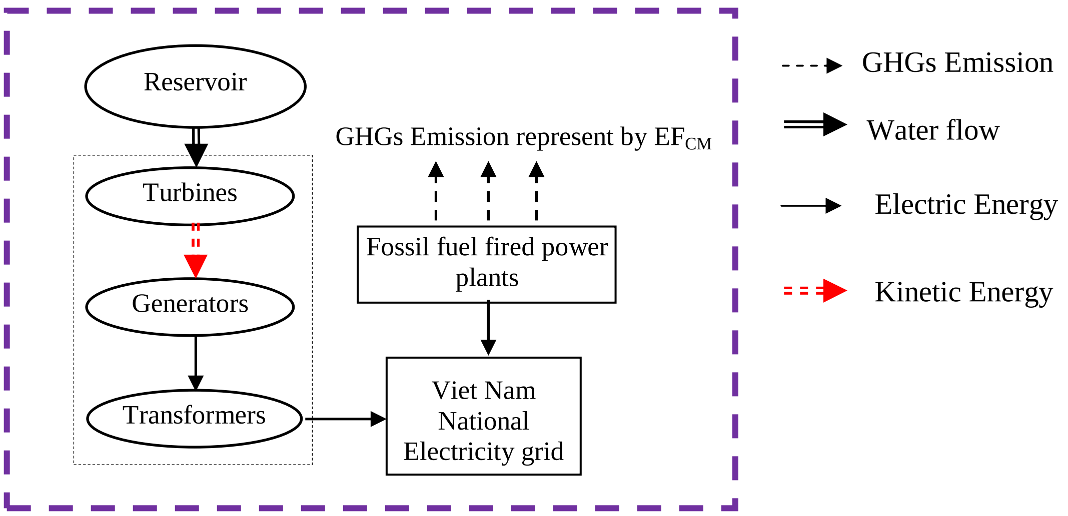

Figure 3: Project boundary

The GHGs and emission sources included in the project boundary are shown in Table 4.

Table 4: Sources and gases included in or excluded from the project boundary

	Source	Gas	Included?	Justification/Explanation
Baseline	CO_2 emission from electricity generation in fossil fuel fired power plants that are displaced due to the project activity.	CO_2	Yes	Main emission source.
		CH_4	No	Minor emission source.
		N_2O	No	Minor emission source.
Project Activity	For hydro power plants, emissions of CH_4 from the Reservoir.	CO_2	No	Minor emission source.
		CH_4	No	Main emission source. Because the power density of the project is less than 10 W/m^2 CH_4 emissions are calculated according to ACM0002, Version 12.2.0.
		N_2O	No	Minor emission source.

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

According to Version 12.2.0 of ACM0002, if the project activity is the installation of a new grid-connected renewable power plant, the baseline scenario is defined as 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 calculations described in the “Tool to calculate the emission factor for an electricity system”".

The Viet Nam national electricity grid, which is operated and monopolized by the EVN and is the unique transmission and distribution line, to which all power plants in Viet Nam are physically connected is the project electricity system.

Thus the baseline scenario of the proposed project is the delivery of equivalent amount of annual power output from the Vietnam national grid to which the proposed project is also connected. The database for calculating the baseline is published by the DNA of Vietnam.

The analysis and description in B.5 and B.6 will support the baseline scenario shown above.

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

According to Version 12.2.0 of ACM0002, the latest version of the “Tool for the demonstration and assessment of additionality” shall be used to demonstrate the additionality of this project activity - version 06.0.0 of the additionality tool includes the following steps:

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

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

Paragraph 4 of the "tool for demonstration and assessment of additionality", version 06.0.0 states "Project activities that apply this tool in context of approved consolidated methodology ACM0002, only need to identify that there is at least one credible and feasible alternative that would be more attractive than the proposed project activity".

The following two scenarios are therefore considered through the analysis:

- Alternative 1: the proposed project is undertaken without the CDM
- Alternative 2: continuation of the current situation. In this case, the proposed project will not be constructed and the power will be solely supplied from the Viet Nam national grid.

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

The alternative 2 "continuation of the current situation" does not face any barrier from the current law and regulation in Viet Nam because it is the "do-nothing" alternative. The project owner of a proposed project has no obligation to build or invest in the power plant to supply electricity for the local area. Hence this alternative is consistent with mandatory laws and regulations.

The Song Bung 5 hydropower project is received the Investment License No.22/CN-UBND issued by People's Committee of Quang Nam province on 11/05/2009, which defines legal right of the project owner to invest in and construct Song Bung 5 hydropower project. Therefore, the alternative 1 "the proposed project is undertaken without the CDM" is consistent with mandatory laws and regulations of Viet Nam.

<u>Step 2: Investment analysis</u>

Sub-step 2a: Determine appropriate analysis method

The proposed project activity generates financial and economic benefits other than CER revenues i.e. revenues from the sale of electricity generated by the project under a PPA signed with a power purchaser, so the simple cost analysis (Option I) is not applicable. Out of the two remaining options, as there are no other credible and realistic baseline scenario alternatives other than electricity supply from the grid, Option II is also not applicable. Thus, the benchmark analysis (Option III) is chosen to prove additionality.

Sub-step 2b – Option III: Apply benchmark analysis

In the following, Project IRR is used to demonstrate the Additionality of the project.

Provided that the proposed project is financed by **both equity and loan** sources, the appropriate benchmark is WACC which represents the weighted average of the costs of various sources of financing in the financing structure. This benchmark represents the minimal required Project IRR of the project to be economically attractive.

The WACC benchmark is indicated in paragraph 12, Annex: Guidance on Assessment of Investment Analysis, Version 05, Annex 05, EB 62, "*Local lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR*". Thus the project participant applies the following WACC equation to estimate the *required return on capital* as a benchmark for this project IRR:

$$WACC = E * R_e + D * R_d * (1 - T_c) \qquad (1)$$

Where:

R_e : cost of equity

R_d : cost of debt

E : Average industry equity ratio

D : Average industry debt ratio ($D = 1 - E$)

T_c : Average enterprise tax rate (is set equal to zero for pre-tax analysis)

This WACC is the "*the cost of financing and required return on capital*" which is "*based on private equity investors/fund"* required return on comparable projects" as presented in Option III, Item (6)(b) of "*Tool for the demonstration and assessment of additionality*" version 05.2.1.

And it also reflects a common-practice approach in investment decision-making in Viet Nam as this approach was also introduced by the Ministry of Industry to conduct the financial analysis of IPP projects in Viet Nam[13].

Determine the cost of debt

At the time of decision making, the prime rate regulated by the State Bank of Vietnam was 7%[14]. The commercial lending rate is regulated by the Civil Code in Vietnam. As per the Civil Code, commercial banks cannot charge a rate of interest more than 1.5 times the prime rate. Thus, the project owner chose a lending rate of 10.50% as the cost of debt.

In the IMF Country Report No.10/281, the lending rate for short-term loan in 2009 is 12.7%, which is much higher than the chosen lending rate.

The applied cost of debt of 10.5% at the date of making the investment decision is conservative and standard.

Determine the cost of equity

To derive an appropriate cost of equity for electricity generation project type in Viet Nam, the following well-known CAPM[15] standard formula, which describes the relationship between risk and expected return, is employed:

$$R_e = R_f + \beta * (R_{m,} - R_f) \qquad (2)$$

Where:

$R_{e,}$ cost of equity for electricity generation project type

R_f Risk free rate return

β Beta of the security for electricity generation project type

$R_{m,} - R_{f,}$ Market risk premium

Risk free rate:

[13] Decision No. 2014/QD – BCN issued by the Ministry of Industry provides temporary guidelines for conducting the economic, financial and investment analysis and providing the purchasing-selling price frame for power generation projects

[14] http://www.sbv.gov.vn/wps/portal/vn

[15] In financial analysis, the **Capital Asset Pricing Model (CAPM)** is used to determine a theoretically appropriate required rate of return of an asset, if that asset is to be added to an already well-diversified portfolio, given that asset's non-diversifiable risk. The model takes into account the asset's sensitivity to non-diversifiable risk (also known as systemic risk or market risk), often represented by the quantity beta (β) in the financial industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset.

The risk free rate is understood as the rate of return on an asset that is theoretically free of any risks, therefore the rate of interest on government bonds are considered as risk free rates. Accordingly the risk free rate has been taken from long term Vietnamese government bond rates available at the date of making the investment decision. The data on government bond rates is published on Hanoi Stock Exchange.

The risk free rate applied is 16% for 15 years term[16].

Beta:

Beta (β) indicates the sensitivity of the company to market risk factors. Beta represents the market risk for an asset and is calculated as the statistical measure of volatility of a specific asset/investment relative to the movement of a market group. The conventional approach for estimating beta of an investment is a regression of returns on investment against returns on a market index. For companies that are not publicly listed like Power Engineering and Consulting Joint Stock Company, the beta is determined by referring to beta values of publicly listed companies that are engaged in similar types of business. The project activity type is power generation; therefore the applied beta for this project should be based on the beta values of listed power generation companies in Viet Nam.

Due to the difference in capital structure (Dept/Equity) between these companies and Power Engineering and Consulting Joint Stock Company, the Beta applied for this CDM project has to be adjusted according to the following steps:

Step 1 – It is obtained the Levered Betas of hydropower companies published in stock market with its own capital structures;

Step 2 – The Beta is Unlevered according the average capital structure of the companies; The unlevered beta is the beta of a company without any debt. Unlevering a beta removes the financial effects from leverage[17].

Step 3 – The Unlevered Beta is levered again according to the capital structure of the Song Bung 5 Hydropower project. This Levered Beta was used for calculation of cost of equity of the Song Bung 5 Hydropower Project.

Table 5: Betas of similar companies in hydro power generation[18]

Company name	**Levered Beta of similar projects**	**D/E**	**Unlevered Beta**	**Levered Beta for CDM project**
Vinh Son Song Hinh Hydropower Company	0.97	0.12	0.89	2.45
Ry Ninh II Hydropower JSC	0.66	0.79	0.42	1.14
Thac Ba Hydropower Company	1.08	0.15	0.79	2.17
Naloi Hydropower JSC	1.10	0.52	0.79	2.17

16 http://www.hastc.org.vn/Danhsach_TCDKGD_TraiPhieu.asp?TxtStockName=tatca&txtSearch=1&fromDate=&txtCompanyName=&SearchType=1&Submit=T%C3%ACm&stocktype=1&actType=1&menuid=114000&menuup=402000&menulink=400000&menupage=Danhsach_TCDKGD_TraiPhieu.asp

17 http://www.investopedia.com/terms/u/unleveredbeta.asp

18 The betas of these companies have been calculated by the project developer based on the published daily data. The link of sources are included in the attached excel sheet

Nam Mu Hydropower JSC	0.92	3.95	0.23	0.34
Can Don Hydropower JSC	0.82	1.91	0.34	0.92
Thac Mo Hydropower JSC	0.38	0.98	0.22	0.61
Mien Trung Power Investment and Development JSC	0.57	1.59	0.26	0.72
Average Beta				**1.42**

Risk Premium:

The most common approach for estimating the risk premium is to base it on historical data, in the CAPM model, the premium is estimated by looking at the difference between average return on stocks and the risk free rate return. The average return on stocks is defined as the compounded annual return.

Table 6: Market expected return calculation

Market index (VN Index) as of 28-Jul-2000	100.00
Market index (VN Index) as of 13-Sep-2009	548.00
No. of years	9.13
Compounded annual return	**20.47%**

Substituting

R_f = 16%;

R_m = 20.47%;

β = 1.42

in (2), we get the **cost of equity for power generation projects in Viet Nam at the date of decision making of the proposed project** as follows:

$$R_e = 22.33\%$$

This rate of the cost of equity for power generation sector meets the EB rules because it reflects a sector specific approach. It is calculated based on similar companies operating in power generation sector in Viet Nam therefore it reflects "*standard in the market, considering the specific characteristics of the project type (…)*" as stipulated in the guidance given in the latest additionality tool under sub-step 2b (5).

The table below presents key assumption to calculate the benchmark - WACC according to formula (1)

Table 7: Key assumptions to calculate the benchmark

No	Parameter	Symbol	Unit	Value
1	Average industry equity ratio	E	%	30
2	Cost of equity	R_e	%	22.33

3	Average industry debt ratio	*D*	%	70
5	Cost of debt	R_d	%	10.5
6	Average business revenue tax during the life time[19]	T_c	%	25
7	**Weighted Average Cost of Capital (Benchmark)**	***WACC***	**%**	**12.21**

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

The key assumptions used to calculate the project IRR of the proposed project are presented in Table 6:

Table 8: Key assumption for investment analysis

No	Parameter	Unit	Value	Source
1	Gross capacity	MW	57	Feasibility Study Report.
2	Annual net electricity generation	MWh	226,884.9	The gross power generation subtracts 1.5% for parasitic and loss load.
3	Total investment cost	billion VND	1,297.989	Feasibility Study Report.
4	Total annual O&M cost	%	1	Decision No. 2014/QD-BCN issued by the Ministry of Industry on 13 June 2007.
5	Preparation period pre-construction	year	01	Feasibility Study Report.
6	Construction period	year	03	Feasibility Study Report.
7	Life time[20]	year	38	Lifetime for financial analysis was based on the lifetime of equipment according to EB 50, Annex 15.
8	Electricity price	VND/kWh	714	The electricity price expected in the Feasibility Study Report[21].
9	Resources tax	%	2	The Circular No 45/2009/TT-BTC was issued by Ministry of Finance on 11 March 2009 regulates that the resource tax will be calculated as the net electricity outputs supplied to the national electricity grid x 2% x average electricity price of 940 VND/kWh as regulated in he Decision No. 720/QD-BTC dated 9 April 2009 of the

[19] The average enterprise tax according to the Government Decree No 124/2008/ND-CP

[20] Maximum of project lifetime regulated at EB50 Report, Annex 15

[21] Feasibility Study Report

				Ministry of Finance.
10	Income tax	%	25	Decree No.124/2008/ND-CP dated 11 December 2008 of the Government on the implementation of enterprise tax law , Chapter 2, Article 10 Item 1
11	**Project IRR**	**%**	**8.54**	

This table shows that the Project IRR of the project was lower than the benchmark at the time of decision making which is defined as the date of issuing the Investment Decision on implementing the investment project by the Management Board on 14 September 2009.

All financial data are available to the DOE for Validation.

Sub-step 2d: Sensitivity analysis

A sensitivity analysis of the project activity has been conducted to test the robustness of the above calculations. As guided in Annex 20 "Guidelines on the Assessment of Investment Analysis, version 05", EB 62 "Only variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation (all parameters varied need not necessarily be subjected to both negative and positive variations of the same magnitude),...", therefore, the following parameters are considered in the sensitivity analysis of the project activity and total O&M cost is appropriately excluded from the analysis:

- Annual export to the national grid
- Investment cost
- Feed-in price set by EVN

Table 7 shows the impact of variations in key factors on the Project IRR considering a ±10% variation in the parameters.

Table 7: Sensitivity analysis

No	Parameter	Variation[22]	IRR	Likelihoods to happen
1	Annual amount of electricity exported to the national grid	+10%	9.49 %	Lower than the benchmark.
		0%	8.54	Project IRR
		-10%	7.54 %	Lower than the benchmark.
2	Total investment costs	+10%	7.67 %	Lower than the benchmark.
		0%	8.54	Project IRR
		-10%	9.56 %	Lower than the benchmark.
3	Electricity price set by EVN	+10%	9.52 %	Lower than the benchmark.
		0%	8.54	Project IRR
		-10%	7.51 %	Lower than the benchmark.

In conclusion, the proposed CDM project activity is unlikely to be financially attractive.

[22] ±10% is selected according to the Decision No. 2014/QĐ – BCN issued by the Ministry of Industry, dated 13 June 2007 to provide temporary guidelines for conducting the economic, financial and investment analysis and providing the purchasing-selling price frame for power generation projects. It is also common-practice for sensitivity analysis for additionality demonstration. Furthermore, ±10% is also a common practice rate for sensitivity analysis of a CDM project.

Step 3: Barrier analysis

Not applied.

Step 4: Common practice analysis

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

Government Decree No 45/2001/ND-CP on power generation and consumption, which was issued on 2 August 2001 and was entered into force 15 days after the issuance date, created a legal basis to allow other entities to invest in and generate electricity rather than only state-owned entities as previously regulated. Before that time, all power plants have been invested from the state budget sources and operated by state owned companies. Hence, any hydropower projects that have started the construction activities before August 2001 are not subject to this analysis.

According to Viet Nam Construction Code - TCXDVN 285:2002 "Irrigation projects - Major standards on designing"[23] hydropower projects are categorized as follows:

Table 8: Groups of hydropower projects according to Viet Nam Construction Code - TCXDVN 285:2002

Group	Installed capacity
I	equal and larger 300 MW
II	equal and larger 50 MW but smaller 300 MW
III	smaller 50 MW but equal and larger 5MW
IV	smaller 5 MW but equal and larger 0.2MW
V	up to 0.2MW

According to the Prime Minister's Decision No.176/2004/QD-TTg which defines the legal entities against the project scales, private entities are not encouraged to invest in hydropower projects with capacity above 100 MW. Furthermore, according to the Decision No.3454/QD-BCN dated 18 October 2005 of the Ministry of Industry defining the jurisdictions to approve the Master Plans and management hierarchy for small scale hydropower projects, hydropower projects having installed capacity within the range 1 MW to 30 MW are categorised as small scale projects.

To serve the purpose of this analysis and in order to categorise hydropower projects in correspondence with the existing regulations mentioned above, hydropower projects are categorised into groups as follows:

Table 9: Groups of hydropower projects serving for common practice analysis

Group	Installed capacity	Referred regulations
A	equal and larger 300 MW	Vietnam Construction Code - TCXDVN 285:2002
B	larger 100 MW and smaller 300 MW	Vietnam Construction Code - TCXDVN 285:2002 and Prime's Minister Decision No 176/2004/QD-TTg
C	equal and larger 50 MW and equal and smaller 100 MW	Vietnam Construction Code - TCXDVN 285:2002
D	smaller 50 MW and larger 30MW	Vietnam Construction Code - TCXDVN 285:2002 and Decision of Ministry of Industry - No: 3454/QD-BCN, Prime's Minister Decision No 176/2004/QD-TTg
E	equal and smaller 30 MW and larger 5MW	Vietnam Construction Code - TCXDVN 285:2002 and Decision of Ministry of Industry - No: 3454/QD-BCN,

[23] Construction Code regulates the basic technical standards that are mandatory for construction activities in Viet Nam.

		Prime's Minister Decision No 176/2004/QD-TTg
F	up to 5MW	Vietnam Construction Code - TCXDVN 285:2002 and Decision of Ministry of Industry - No: 3454/QD-BCN, Prime's Minister Decision No 176/2004/QD-TTg

According to Table 9, this proposed project activity falls into Group C.

The comparison of the hydropower plants which belong to Group C but were developed without CDM and started construction after August 2001 and the proposed project activity is presented in Table below.

Table 10: Hydropower plants which belong to group C (50 < P_{dm} ≤ 100 MW) were developed in Viet Nam

No	Name	Capacity MW	Elec. outputs 10^3 MWh	Load factor (%)	Construc-tion starting year	Commi-ssioning year	Investor during the investment and construction period
0	**The proposed project**	***57***	***230,340***	**46.1**[24]	**2009**	**2012**	***Power Engineering and Consulting Joint Stock company*** (private company)
A. Invested and constructed by state-owned companies or joint stock companies which are either state-owned or whose major shares held by the government							
1	Quang Tri	64	217.4	38.8	2003	2007	EVN[25]
2	Srok Phu Mieng	51	228	51.0	2003	2006	Viet Nam Urban and Industrial Zone Development Investment Corporation[26] - IDICO (State-owned Corporation belongs to Ministry of Construction)

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

The existence of these hydropower plants does not contradict the result of the benchmark analysis stating that the proposed project is financially unattractive, because of the following reasons:

1. The Quang Tri project is one of the priority project invested by the state budget and by the EVN.
2. The Srok Phu Mieng is not only invested and operated by IDICO but also constructed by them. IDICO is “the State Corporation under the Ministry of Construction in accordance with the Decision No. 90/TTg dated March 7th 1994 by the Prime Minister.”.. Being a state-owned enterprise, it enjoys a lot of incentives and supports from the Government including tax exception,

[24] The Plant load factor (PLF) for this proposed project was determined by the annual electricity output and the capacity which were provided by the third party contracted by the project owner. So it is in line with the EB 48 annex 11 “The plant load factor determined by a third party contracted by the project participants (e.g. an engineering company)”
PLF = (Total electricity output / Maximum electricity could be generated) or
PLF = (the annual electricity output / (the capacity*8760) * 100%). In which 8760 is hours of one year.
So PLF for this proposed project = 230,340 / (57 * 8760) * 100% = 46.1%.

[25] http://www.hanoimoi.com.vn/newsdetail/Kinh-te/30758/ng259n-song-rao-quan-th7911y-273i7879n-qu7843ng-tr7883.htm and http://www.vncold.vn/Web/Content.aspx?distid=1111

[26] http://www.idico.com.vn/index.php?Bcat=1&lg=vn&start=0

tax reduction, preferential loan, pay-back extension, priority to own the projects invested in by the State, etc.[27]

Besides, all the above listed project have been constructed in 2003 when energy demand was very urgent to meet the “hot” development growth rates of Viet Nam but the price of labour, construction materials, machine is quite cheap and stable. Thus, these project owners could invest in these projects to pursuit the development strategy of the government of Viet Nam. In recent years, Viet Nam has been suffered a high inflation with a sharply increase in prices of construction materials. As a result, the government has promulgated the tightening monetary policy to reduce the annual growth rate in order to control inflation. It therefore gets more difficult to arrange sufficient loan for a non attractive investment project

As can be seen from the above analysis, the proposed project is not a common practice in Vietnam.

Implementation timeline of the proposed project activity

CDM early consideration and the serious actions to secure the CDM status for the project are reflected in the key milestones in the development of the project listed below:

Table 11: Major milestones in developing the investment project and CDM application

Development of the hydropower project	Activities taken to achieve CDM registration	Time	Implication on CDM
I. Legal & administrative formality to be considered as the project owner			
Approving Environmental Impact Assessment Report		21-Feb-2008	
Finalising the Basic Design report		Feb-2009	
	Achieving the Minutes of meetings to consult public opinions (local people and local authorities) on the social and environmental impacts of the hydropower project in order to develop it as a CDM activity.	02-Mar-2009 & 03-Mar-2009	*CDM early consideration*
Issuing the Investment License for the project		11-May-2009	
	Official letter submitted by the project owner to People’s Committee (PPC) of Quang Nam province requesting verification and support for the CDM project.	20-Aug-2009	*CDM early consideration*
	Official letter submitted by the Project owner to the DNA requesting verification and support for the CDM project.	20-Aug-2009	*CDM early consideration*

27 http://tanphu.org.vn/vn/van-ban/phat-trien-kinh-te/phat-trien-cac-loai-hinh-doanh-nghiep-trong-nen-kinh-te-nhieu-thanh-phan/

Issuing the Investment Decision on implementing the investment project and CDM project by the Management Board.		14-Sept-2009	*Date of making CDM project Investment decision*
Signing the construction contract		21-Dec-2009	*Starting date of the project activity*
	Official letter submitted by the People's Committee of Quang Nam province to the DNA requesting verification and support for the CDM project.	06-Jan-2010	
	Notifying the CDM project to the EB and the DNA	07-Jun-2010	
Signing the Equipment Contract		19-Aug-2010	
Issuing the approval of FSR for the proposed project		30-May-2011	

In conclusion, the proposed project is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The reduced emission is calculated in accordance with the approved consolidated baseline methodology Version 12.2.0 of ACM0002.

I. Project emissions *(PE_y)*

According to ACM0002, Version 12.2.0, the project emissions are calculated using the following equation:

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

Where:

PE_y	Project emissions in year *y* (tCO_2e/yr)
$PE_{FF,y}$	Project emissions from fossil fuel consumption in year *y* (tCO_2/yr)
$PE_{FF,y}$	Project emissions from the operation of geothermal power plants due to the release of non-condensable gases n year *y* (tCO_2e/yr)
$PE_{HP,y}$	Project emissions from water reservoirs of hydro power plants in year *y* (tCO_2e/yr)

The proposed project is a hydro power plant that neither uses fossil fuel nor operates geothermal power plants (i.e. $PE_{FF,y} = 0$; $PE_{GP,y} = 0$); therefore, the above equation can be shortened as follows:

$$PE_y = PE_{HP,y}$$

Emissions from water reservoirs of hydro power plant ($PE_{HP,y}$)

For hydropower project activity that results in new reservoirs and/or the increase of existing reservoirs, the power density (PD) of the project activity shall be calculated as follows:

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

Where:

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

(a) If the *PD* is greater than 4 W/m^2 and less than or equal to 10 W/m^2:

$$PE_{HP,y} = \frac{\mathrm{EF}_{\mathrm{Res}} \cdot TEG_y}{1000}$$

Where:

$PE_{HP,y}$	Emission from reservoir expressed as tCO_2e/year
EF_{Res}	Default emission factor for emissions from reservoirs of hydro power plants in year y ($kgCO_2e$/MWh)
TEG_y	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh).

(b) If *PD* is greater than 10 W/m^2, then:

$$PE_{HP,y} = 0$$

II. Baseline emissions *(BE_y)*

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity, calculated as follows:

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

Where:

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

Calculation of the emission factor (EF) of the national electricity grid

The Version 02.2.1 of "Tool to calculate the emission factor for an electricity system" determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "operating margin" and "build margin" as well as the "combined margin", including 6 steps as follows:

STEP 1. Identify the relevant electric power system.

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) emission factor.

Step 1. Identify the relevant electricity systems

This hydropower project will be connected to the national electricity grid of Vietnam, which is operated and monopolized by the EVN. This national electricity grid is the unique transmission and distribution line, to which all power plants in Vietnam are physically connected. Hence the national electricity grid is the project electricity system.

There are electricity imports to the national electricity grid from China - another host country, thus the China Power Grid is the connected electricity system and the emission factor for the imported electricity is zero tons CO_2 per MWh by default.

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

There are 2 options in the tools to choose, including:
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.
Because only the data of grid connected power plants is available, so Option I will be chosen for calculating the grid emission factor.

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

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

a) Simple OM;

b) Simple adjusted OM;

c) Dispatch data analysis OM;

d) Average OM.

The method (a) can be used in the project because low-cost/must-run resources in Vietnam is 34.77 % that constitute less than 50% of total grid generation in average of the five most recent years (details see the table below).

Table 9: Rate of low cost/must-run sources based on generation[28]

Year	2004	2005	2006	2007	2008	Average Value for 2004-2008
Hydro Power (MWh)	17,858,651	16,365,438	19,508,244	22,385,232	25,933,762	102,051,327
Total Power (MWh)	44,974,169	50,330,468	57,160,493	66,348,589	74,689,636	293,503,355
Low-cost/Must-run Ratio	39.71%	32.52%	34.13%	33.74%	34.72%	34.77%

The data vintage which is used to calculation the Simple OM emission factor is the Ex-ante option of a 3-year generation-weighted average (2006, 2007 and 2008) that is the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period.

Step 4. Calculate the OM emission factor according to the selected method

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants units.

There are two Options proposed, including:

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

Because the data for Option A is available, Option A "*Calculation based on average efficiency and electricity generation of each plant"* is used and then the simple OM emission factor is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,OM,y}$ = Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m = All power plants/units serving the grid in year *y* except low-cost/must-run power plants/units

[28] Data source from DNA Viet Nam

y Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)

Because the data on fuel consumption and electricity generation of power unit *m* is available, so the emission factor ($EF_{EL,m,y}$) should be determined as **Option A1** :

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

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

$FC_{i,m,y}$ = Amount of fossil fuel type *i* consumed by power plant/unit *m* in year *y* (mass or volume unit)

$NCV_{i,y}$ = Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)

$EF_{CO2,i,y}$ = CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)

$EG_{m,y}$ = Net 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 unit *m* in year *y*

y = The relevant year as per the data vintage chosen in Step 3

Table 10: OM emission factor in 2008

Year	**Total output (MWh)**	**Total emission (tCO2e)**	**OM 2008 (tCO2e/MWh)**
	A	**B**	**(ΣB/ΣA)**
2006	37,618,199.00	25,702,918.00	
2007	43,921,501.00	28,544,283.00	
2008	48,719,874.00	29,963,699.00	
Total	**130,259,574.00**	**84,210,900.00**	**0.6465**

So $EF_{grid,OMsimple,y}$ is derived as follows:

$$EF_{grid,OMsimple,y} = 0.6465\ tCO_2/MWh$$

Step 5. Calculate the BM emission factor

In terms of vintage of data, one of the following two options can be chosen:

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

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

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

The most recent information on units already built for sample group *m* is available, so Option 1 shall be chosen for the proposed project.

The sample group of power units *m* used to determine as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

In 2008, the set of five power units that have been built most recently ($SET_{5\text{-units}}$) is indicated in Annex 3 has annual generation ($AEG_{SET\text{-}5\text{-units}}$) of 7,829,812.02 MWh.

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

The total output of Vietnam electricity grid (AEG_{total}) in 2008 is 74,689,635.97 MWh then 20% of the total output of Vietnam electricity grid in 2008 is 14,937,927.19 MWh.

Most recent-built power plants ($SET_{\geq 20\%}$) *addition in the electricity system that comprise 20% of the system generation in 2008 is shown in the annex 3 have annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$) of 16,514,761.12 MWh.*

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}).

The comparison carried out by the project participants shows that the set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) that have been built most recently has the larger annual generation (14,937,927.19 MWh) than the set of five power units that have been built most recently in 2008 does (7,829,812.02 MWh), and hence it is employed and SET_{sample}.

There is no plant in SET_{sample} is started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin.
The BM emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available. It is calculated as follows:

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

Where:

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

Then $EF_{grid,BM,y}$ is derived as follows:

$$\boldsymbol{EF_{grid,BM,y} = 0.5064\ tCO_2/MWh}$$

Step 6. Calculate the combined margin emissions factor

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

(a) Weighted average CM; or
(b) Simplified CM

As the project is located in Vietnam a developing country and having more than 10 registered projects at starting date of validation, the PP chooses the weighted average CM method to calculate CM emission factor for the proposed project.

The CM emissions factor is calculated as follows:

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

Where:

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

For the proposed project, the following default values are used: w_{OM}= 0.5 and w_{BM} = 0.5 in the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 in the second and third crediting period.

So in the first crediting period, the CM emission factor is derived as follows:

$$\boldsymbol{EF_{grid,CM,y} = 0.5 \times 0.6465 + 0.5 \times 0.5064 = 0.5764\ tCO_2/MWh}$$

The baseline emission factor EF shall be fixed for the crediting period.

III. Leakage *(LE_y)*

The main emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g. extraction, processing, transport). But according to ACM0002, Version 12.2.0 these emission sources do not need to be considered as leakage, therefore $\boldsymbol{LE_y = 0}$.

IV. Emission reductions *(ER_y)*

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

ER_y = Emission reductions in year y (tCO_2e/yr).

BE_y = Baseline emissions in year y (tCO_2/yr)

PE_y = Project emissions in year y (tCO_2/yr).

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

Data / Parameter:	**Cap_{BL}**
Data unit:	MW
Description:	Installed capacity of hydropower plant before the implementation of the project activity.
Source of data used:	Project site
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project activity constructs a new hydropower plant, so Cap_{BL} is considered to be zero according to Version 12.2.0 of ACM0002.
Any comment:	For calculation of PD.

Data / Parameter:	**A_{BL}**
Data unit:	m^2
Description:	Area of the reservoir measured in the surface of the water, before the implementation of the project activity, when the reservoir is full. For new reservoirs, this value is zero.
Source of data used:	Project site
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The project activity builds a new reservoir, so A_{BL} is considered to be zero according to Version 12.2.0 of ACM0002.
Any comment:	For calculation of PD.

Data / Parameter:	**$EF_{grid,OM,y}$**
Data unit:	tCO_2/MWh
Description:	Operating margin CO_2 emission factor for grid connected power generation in year y calculated using the latest version of "Tool to calculate the emission factor for an electricity system, version 02.2.1"

Source of data used:	Data published by DNA Viet Nam
Value applied:	0.6465
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per the “Tool to calculate the emission factor for an electricity system, version 02.2.1”
Any comment:	For calculation of $EF_{grid,CM,y}$

Data / Parameter:	$EF_{grid,BM,y}$
Data unit:	tCO_2/MWh
Description:	Building margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of “Tool to calculate the emission factor for an electricity system, version 02.2.1”
Source of data used:	Data published by DNA Viet Nam
Value applied:	0.5064
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per the “Tool to calculate the emission factor for an electricity system, version 02.2.1”
Any comment:	For calculation of $EF_{grid,CM,y}$

Data / Parameter:	EF_{grid},CM,y
Data unit:	tCO_2/MWh
Description:	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of “Tool to calculate the emission factor for an electricity system, version 02.2.1”
Source of data used:	Data published by DNA Viet Nam
Value applied:	0.5764
Justification of the choice of data or description of measurement methods and procedures actually applied:	As per the “Tool to calculate the emission factor for an electricity system” Version 02.2.1
Any comment:	Fixed for crediting period.

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

Project emissions (PE_y)

The proposed project activity involves the construction of a new hydropower plant with capacity (Cap_{PJ}) of 57 MW and a new reservoir with surface (A_{PJ}) of 168 ha, thus A_{BL} = 0 and Cap_{BL} = 0.

The power density of the project activity is derived as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} = \frac{57 \times 10^6 - 0}{168 \times 10^4 - 0} = 33.9(W / m^2)$$

As power density of two reservoirs is greater than 10 W/m^2, the project emission is zero; and the monitoring of total electricity output shall be excluded from the monitoring plan.

$$PE_{HP,y} = 0$$

Therefore,

$$PE_y = 0$$

Baseline emissions (*BE*$_y$)

Baseline emissions include only CO2 emissions from electricity generation by fossil fuel fired power plants that are displaced due to the project activity. It is calculated as follows:

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

Where:

BE_y	Baseline emissions in year *y* (tCO_2/yr).
$EG_{PJ,y}$	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr), and equal to 226,884.9 MWh/yr
$EF_{grid,CM,y}$	= 0.5764 tCO_2/MWh

Therefore:

$$BE_y = 226{,}884.9 \times 0.5764 = 130{,}776 \ (tCO_2/yr)$$

Leakage (*LE*$_y$)

As it is stated in ACM0002 Version 12.2.0, theses emissions are considered as zero: LEy = 0.

Reduction emissions (*ER*$_y$)

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y = 130{,}776 – 0 = 130{,}776 \ (tCO_2/year)$$

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

The estimated emission reduction of the project activity is provided in Table 12.

Table 12: Emission reduction of the project activity

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of overall emission reductions (tonnes of CO_2e)
2012 (01/07/2012 – 31/12/2012)	0	65,388	0	65,388
2013	0	130,776	0	130,776
2014	0	130,776	0	130,776
2015	0	130,776	0	130,776
2016	0	130,776	0	130,776
2017	0	130,776	0	130,776
2018	0	130,776	0	130,776
2019 (01/01/2019 – 30/06/2019)	0	65,388	0	65,388
Total (tCO_2 e)	**0**	**915,432**	**0**	**915,432**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$EG_{y, export}$**
Data unit:	MWh
Description:	Electricity supplied by the proposed hydropower plant to the national grid.
Source of data to be used:	Direct measurement at the connection point.
Value of data applied for the purpose of calculating expected emission reductions in section B.6	226,884.9
Description of measurement methods and procedures to be applied:	Two-way power meters will be installed at the grid-connected point to measure the amount of electricity supplied to the grid by the proposed project by the positive direction. The readings of electricity meter will be continuously measured by power meter and monthly recorded. The recorded data will be confirmed by the joint balance sheet which will be signed by the representatives of EVN and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.

Monitoring frequency	Continuously measured by power meter and monthly recording.
QA/QC procedures to be applied:	The uncertainty level of this data is low. The measurement/ monitoring equipment should be complied with national standard and technology. These equipment and systems should be calibrated and checked in accordance with relevant laws of the host country.
Any comment:	For $EG_{facility,y} = EG_{y,\ export} - EG_{y,\ import}$

Data / Parameter:	$\mathbf{EG_{y,\ import}}$
Data unit:	MWh
Description:	Electricity supplied by the 220 kV grid and 22kV grid to the proposed hydropower plant
Source of data to be used:	Direct measurement at the project site
Value of data applied for the purpose of calculating expected emission reductions in section B.6.3.	$EG_{y,import} = EG_{y,import,\ 220kV} + EG_{y,\ import,\ 22kV} = 0$
Description of measurement methods and procedures to be applied:	Power meters will be installed at the 220kV grid-connected point and one meter will be installed at the 22kV grid – connected point to measure the amount of electricity supplied by the grids to the proposed hydropower plant. The readings of electricity meters will be continuously measured by power meter and monthly recorded. The recorded data will be confirmed by the joint balance sheet which will be signed by the representatives of EVN and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.
Monitoring frequency	Continuous measurement and at least monthly recording
QA/QC procedures to be applied:	The uncertainty level of this data is low. The measurement/ monitoring equipment should adopt the colligated automation system complying with national standard and technology. These equipment and systems should be calibrated and checked in accordance with relevant laws of the host country.
Any comment:	Use for calculating $EG_{facility,y,} = EG_{y,\ export} - EG_{y,\ import}$

Data / Parameter:	$\mathbf{EG_{y,\ import,\ 220kV}}$
Data unit:	MWh
Description:	Electricity supplied by the national grid to the proposed hydropower plant
Source of data to be used:	Direct measurement at the connection point
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0
Description of measurement methods and procedures to be applied:	Power meters will be installed at the 220kV grid-connected point to measure the amount of electricity supplied by the grid to the proposed hydropower plant. The readings of electricity meter will be continuously measured by power meter and monthly recorded. The recorded data will be confirmed by the joint balance sheet which will be signed by the representatives of EVN and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.

Monitoring frequency	Continuously measured by power meter and monthly recording
QA/QC procedures to be applied:	The uncertainty level of this data is low. The measurement/ monitoring equipment should be complied with national standard and technology. These equipment and systems should be calibrated and checked in accordance with relevant laws of the host country.
Any comment:	For $EG_{y,import} = EG_{yimport, 220kV} + EG_{y, import, 22kV}$

Data / Parameter:	$\mathbf{EG_{y,import, 22kV}}$
Data unit:	MWh
Description:	Electricity supplied by 22kV grid to the proposed hydropower plant
Source of data to be used:	Direct measurement at the connection point
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0
Description of measurement methods and procedures to be applied:	A power meter will be installed at the 22kV grid – connected point to measure the amount of electricity supplied by the grid to the proposed hydropower plant. The readings of electricity meter will be continuously measured by power meter and monthly recorded. The recorded data will be confirmed by the joint balance sheet which will be signed by the representatives of EVN and the project owner. Electronic data will be archived within the crediting period and 2 years after the end of the crediting period.
Monitoring frequency	Continuously measured by power meter and monthly recording
QA/QC procedures to be applied:	The uncertainty level of this data is low. The measurement/ monitoring equipment should be complied with national standard and technology. These equipment and systems should be calibrated and checked in accordance with relevant laws of the host country.
Any comment:	For $EG_{y,import} = EG_{y,import, 220kV} + EG_{y,import, 22kV}$

Data / Parameter:	$EG_{facility, y}$
Data unit:	MWh
Description:	Net electricity supplied to the national grid by the proposed hydropower plant.
Source of data to be used:	Calculating from $EG_{y, import}$ and $EG_{y, export}$.
Value of data applied for the purpose of calculating expected emission reductions in section B.6	226,884.9
Description of measurement methods and procedures to be applied:	Calculating by subtracting $EG_{y, import}$ from $EG_{y, export}$. Double checking by the joint balance sheet issued by EVN and project owner to ensure the consistency. Data will be archived within the crediting period and 2 years after the end of the crediting period.
Monitoring frequency	Continuously measured by power meter and monthly recording.
QA/QC procedures to be	The uncertainty level of this data is low.

applied:	
Any comment:	For CERs calculation.

Data / Parameter:	$\mathbf{A_{PJ}}$
Data unit:	m^2
Description:	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full.
Source of data to be used:	Project site.
Value of data applied for the purpose of calculating expected emission reductions in section B.6.3.	1,680,000
Description of measurement methods and procedures to be applied:	Measured by the observation equipment
Monitoring frequency	Yearly
QA/QC procedures to be applied:	The uncertainty level of this data is low.
Any comment:	For calculating the power density

Data / Parameter:	Cap_{PJ}
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data to be used:	Project site
Value of data applied for the purpose of calculating expected emission reductions in section B.6.3.	57,000,000
Description of measurement methods and procedures to be applied:	Manufacture's nameplate
Monitoring frequency	Yearly
QA/QC procedures to be applied:	
Any comment:	For calculating the power density

B.7.2. Description of the monitoring plan:

Because the baseline emission factor of Viet Nam National Grid (EFgrid,CM,y) is fixed ex-ante (detail in Section B.6), the main data to be monitored is $EG_{facility,\ y}$. $EG_{facility,\ y}$ will be calculated according to this formula below:

$$EG_{facility,y} = EG_{y,\ export} - EG_{y,\ import}$$

The electricity generated from the project activity will be sold to the EVN for the complete project lifetime under a long-term PPA with EVN.

The electricity generated from the project activity before entering into the grid at the grid interconnection point will be measured by a digital kilowatt hour (kWh) meter. The metering system includes the main

system and a back-up system. The data recorded from the back-up system will be used in case of failing of the main meter.

Data from the operating meters will be continuously measured. Additionally, monthly manual readings will be taken from the operating meters.

Monthly, EVN staff and staff of the operation division of the power plant will cross-check manual meter readings with the electronically recorded data and prepare and sign a joint balance sheet which indicates the amount of power fed into the grid within that month.

This joint balance sheet is also the basis of payment by the EVN to the project proponent. Hence, the monitoring plan is well integrated into the standard EVN procedures.

For further details see Annex 4.

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

Date: 30/03/2011

The responsible entity: **Energy and Environment Consultancy Joint Stock Company (VNEEC)** which is the project participant listed in Annex 1 of this document.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

21/12/2009, the date when the first construction contract was signed.

This is the earliest contract signed by the project owner to commit for the project's expenditures. This is in accordance with the "CDM Glossary of Terms/version 05", which define the starting date of project as "the earliest date at which either the implementation or construction or real action of a project activity begins".

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

38 years[29]

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

C.2.1. Renewable crediting period:

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

01/07/2012 or the date of registration whatever is later

[29] Calculated as turbine lifetime (150,000 hrs) defaulted by Annex 15 to EB 50 Report, page 4 divided by operation time of the project (4,041 hrs)

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including trans-boundary impacts:

Pursuant to Environment Protection Law of Viet Nam 2005 (Article 20) and Decree No.21/2008/ND-CP dated 28 February 2008 of the Government amending and supplementing a number of articles of Decree No. 80/2006/ND-CP on details of regulations and guidance on implementing some Articles of the Environment Protection Law of Viet Nam 2005 issued on 09 August 2006, the Environmental Impact Assessment (EIA) for this project has been carried out. The EIA reports have already been approved by Minister of Natural Resources and Environment by issuing Decision No.267/QD-BTNMT dated 21 February 2008.

Furthermore, based on the impact assessments of the proposed project, the EIA report proposes that the mitigation measures shall be conducted during the construction and operation phases in order to minimize the negative impacts and ensure the long-term benefits from this project.

The surface water license is to be obtained from the Ministry of Natural Resources & Environment before operation as this is mandatory for this type of project in Viet Nam.

The environmental impacts and mitigation measures are summarized as follows.

1.1. Environmental Impacts

1.1.1. Impact on land

The proposed project will occupy about 257.01 ha land[30], of which 162.01 ha is used for the construction of reservoir and 95 ha is used for other items power house, and auxiliary structures etc. The occupied land will be compensated adequately in comply with government laws and regulations.

No historical culture and archaeological places exist in the project site.

1.1.2. Impacts on air and noise

The preparation and construction phase might cause air pollution. Pollutants are almost generated from the operation of auxiliary plants, material vehicles and executing machines. Pollution sources include dust, noise and waste gases from executing machines. This pollution is temporary and will be terminated upon the completion of the construction.

1.1.3. Impacts on water flow

[30] Feasibility Study Report

The project will create a reservoir with surface area of about 168 ha[31] at the average water level of 60m. The creation of reservoir will form a reservoir ecological environment, which facilitates the eco-tourism, and contributing to improve water transport. Water from the reservoir will significantly serve the agro-forestry activities, increase land use proportion. The content of dissolved oxygen as well as other chemical content as pH, turbidity, etc. will not be changed.

1.1.4. Impacts on ecological system

- *Flora*

The Song Bung 5 Hydropower Project does not cross-out any natural conservation areas, national forests or specialized forest.

The implementation of the project will affect about 173.01 ha forest[32], of which 136.2 ha is natural forest, 36.81 production forest, and small area of plants. During the project implementation, there will be a large number of worker gathering in the project site, which causes forest destruction for wood, and crop cultivation. The formation of water transportation activities during the reservoir water retaining period will further bring human beings to forests around the reservoir, which is to disturb ecological system and vegetable cover in here.

- *Fauna*

The project implementation will pose negative impacts on the fauna due to loss of habitats, road construction, animal hunting for food, pharmaceutical products, trade, etc. The creation of transport paths will isolate the movement of wild animals.

After commissioning, the reservoir with its large water surface will cause the local climate to become milder with positive effects on the local fauna and flora, as well as surrounding communities.

- *Aquatic system and fish*

The project implementation will locally affect the aquatic system (mostly at the dam and power house constructions), which impacts will last for short time. The construction of dam will influence some kinds of migrating fish during reproductive season.

1.1.5. Impacts on local environment surrounding the construction site

- *Dusts and gas emissions*: During the construction phase, activities such as area levelling, road making, exploitation/transportation of building materials etc. may emit to the air dusts and gases like CO_x, NO_x, SO_x. These gases have negative impacts on the health of people and animals.
- *Noise:* Noise is caused by mine explosions during the construction and by operation of vehicles. The magnitude of noise and of vibration from mine explosion will affect the exploitation and construction sites.

However, these impacts are temporary and will be terminated after commissioning the construction phase.

1.2. Socio-economic impacts

1.2.1. Negative impacts

The main negative impact is related to the occupation of the land. The proposed project will permanently occupy a certain area of land for the construction of project structures such as dam, power house, reservoir, etc. No historical culture and archaeological places exist in the project site.

There are 16 households affected by the project implementation due to loss of production land, in which there is only one household having to remove to new place. The project hardly affects other structures of the locality. The affected people shall be commensurately compensated for in accordance with applicable laws of the host country.

[31] Feasibility Study Report
[32] EIA report of Song Bung 5 hydropower project

1.2.2. Positive impacts

As presented in Section A.2

1.3. Mitigation measures to reduce negative impacts

1.3.1. Construction phase

- *On soil:*
  - All excavated rock and aggregate will be used in construction where possible, while the spoil will be deposited in areas with minimum landslide potential; layered and covered with soil; and planted with trees, shrubs, and grasses.
- *On water quality:*
  - Avoiding the direct discharge of untreated waste or oil to the river. All waste including domestic and industrial waste shall be collected and transported to proper location (i.e. septic tanks) for the treatment.
  - Clearing the reservoir bed: clearing the designated areas of all trees, down timber, snags, vegetation, rubbish and objectionable material and shall include grubbing stumps and roots and disposing of all material resulting from the clearing or grubbing.
  - Regular monitoring of water quality at stations in the river or auxiliary and resettlement zone.
- *On air quality*
  - Using water spray trucks for dust suppression will mitigate dust generation from construction traffic.
  - All means/vehicles for transport of construction materials must be covered in order to minimize dust dispersion.
  - Means used for the construction shall meet relevant standards required by the host country.
  - Waste and dust after being mitigated shall meet Vietnamese Standard TCVN 5937:2005
- *On noise*
  - Reduce noise from machine via maintenance, turn off intermittent operation machines that are not necessary.
  - Arrange works on day tour, constrain working by night.
  - Using standardized and registered machines to reduce noise and waste gas during their operation.
  - Mine explosion shall be made in proper time
  - Using a sufficient amount of explosives as legally required
- *Waste collection and treatment*
  - Implement regular collection and treatment of solid and liquid wastes, including the construction of a dumping area.
  - Raise awareness of the environmental protection for workers and local people.
- *On flora and fauna*
  - All work will be carried out in such a manner that damage or disruption to vegetation is minimized. After completion of construction activities, temporarily occupied areas will be re-vegetated.
  - Prohibiting forest clearance for crop, fire wood or other purposes.
  - Taking necessary measures to project forest fire such as applying strict measures for preventing fire and explosion at workers huts.
  - Conducting reforestation at the places where forests have been occupied for the project implementation.
  - Prohibiting all kind of animal hunting activities

– The contractors shall raise awareness of environmental protection for workers.

- *Mitigation measures for socio-economic impacts*
- The project owner shall make a plan to implement the measures for protecting human health, examining food safety and hygiene in accordance with regulations of Ministry of Health, Viet Nam, associating with local medical stations in preventing common diseases.
- Project owner shall effectively disseminate the benefits of the implement of the project, provide sufficient information of project implementation, compensation policy, resettlement as per laws.
- Give prior opportunities to the local resident to work for the plant during the construction and operation.

1.3.2. Operational phase

Preventive measures and reaction towards environment problems: Install monitoring equipment to monitor absorption and distortion of water rising and water quality released from the plant and propose suitable preventive measures if required.

1.4. Conclusion

The main negative impacts on the environment are due to construction. However, all these impacts will be mitigated by implementing adequate mitigation measures and then will cease after the completion of the construction phase. Preventive and mitigation measures are planned to be conducted during the operation period to prevent and/or reduce any adverse impacts.

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

Not applicable

SECTION E. Stakeholders' comments

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

The following stakeholders have been consulted:

- People Committee of Quang Nam province (the highest local authority was informed about the CDM development of the proposed project by the project owner via Official letter No.128/CV-TVD1 dated 20 August 2009 and supported to develop this project as a CDM project activity via issuance of the official letter No.44/UBND-KTN on 06 January 2010 which was sent to the DNA of Viet Nam.
- People Committee of Quang Nam province: approving the Overall Plan to compensate and support for resettlement regarding Song Bung 5 hydropower project.
- Local people in the project area in Ma Cooih commune, Dong Giang district, and Thanh My town, Nam Giang district, Quang Nam province were involved directly and actively in commenting on the project implementation and the negotiations on impacted lands and assets due to the project activity. The inventories on damage, and negotiations on compensation have been organised with each household until a mutual agreement has been reached with each affected household. Then the aggregated plan and budget for compensation has been validated and verified by the People's Committee of Quang Nam Province.

Besides, the local people of Ma Cooih commune, Dong Giang district, and Thanh My town, Nam Giang district, Quang Nam province were involved in the consultation process.

One week before holding the stakeholders meetings regarding the proposed project, the stakeholders were informed about project by public radio and notices at the Communal People Committee's office. At the same time they were invited to the official meetings with the project owner to provide their comments. On 02 – 03 March 2009, meetings between the project owner and the following representatives of the local people was held in order to consult local people on the social-economic and environment impacts of the proposed project in order to develop this project as a CDM activity. The stakeholders could immediately raise their comments regarding the proposed project during the meeting or after the meeting by sending their comments directly to the local authorities and/or project owner within fifteen (15) working days. Finally, the project owner in co-operation with local authorities would work on and address the received comments.

- Commune's People Committee (CPC): CPC is the lowest administration level in Viet Nam administrative hierarchy. Chairman of CPC is elected by the Commune People Council, so he well represents the commune's interest.
- Commune's communist party committee: this is one of the key government bodies in making development strategies at the communal level.
- Village's representative: head of village, secretary of young union, head of farmers' association, head of women's association. Such associations are NGOs and represent the interests of different groups.

Then the internal meetings of local commune were organised subsequently to announce the proposed project activity in non-technical terms and local language to local residents.

E.2. Summary of the comments received:

All organizations agreed that the project will certainly contribute to sustainable development and environment protection in Viet Nam and especially this project will increase local budget and reduce poverty. Therefore, they fully support the project to develop under the CDM and recommend the project owner to complete necessary procedures to submit the project to the DNA and to the EB for registration.

Comments of the representatives of local people and local authority are summarized as follows:

a. Positive impact:

- The proposed hydropower project is a clean industrial project and will contribute to socio-economic development of the project's area;
- Create jobs for local people, especially for minority ethnic in highland, reducing the unemployment rate of local.
- Contribute to improving the lives of local people, narrowing the gap in economic and cultural among ethnic groups and among areas in there.
- Contribute to local budgets through tax.
- During project implementation, the contact and work with staff and qualified workers will help improve people's knowledge, experience and learn how to work.
- The development and registration this hydropower project become the CDM project will bring additional revenue sources besides revenue from electricity, thereby helping the project feasibility of finance.

- The local people support the project to develop under the CDM and recommend the project owner to complete necessary procedures to submit the project to the national and international approval bodies.

b. Negative impact:

- Affect local air and water environment during construction phase.

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

To address the requests from local people, the project owner committed to seriously apply and implement mitigation activities as stated in the EIA report in order to minimise negative impacts on local environment, as follows,

- Making commensurately compensation for those who are affected by the project through loss of land in accordance with relevant regulations.
- Making a solid plan to solve environmental impacts in order to avoid effects on public health; providing medical support and health care to the local people.
- Conducting compensatory afforestation
- Absolutely respecting local custom and religion
- Gives opportunities for local people to get jobs at the project during the construction and operation

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding or ODA from the Annex I parties is involved in the project activity.

Annex 3

BASELINE INFORMATION

The Baseline Emission Factor is approved under Official document No.151/KTTBDKH issued on 26/03/2010 by the Department of Meteorology, Hydrology and Climate Change of the Ministry of Natural Resources and Environment on "Vietnam electricity emission factor"

Data sources using to calculation $EF_{CM, grid}$ has been referred to the published data of DNA Viet Nam. The link is accessible at:

http://www.noccop.org.vn/Data/vbpq/Airvariable_ldoc_vnHe%20so%20phat%20thai.pdf

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Introduction

The process of calculating the Vietnam Electricity grid emission factor (EF) in 2008 was conducted then completed in the framework of task "*Calculation of the total national emissions under the plan for the period 2020 to 2025, verify the ability to switch to the clean production mechanism in Vietnam (for Master Plan VI)*" taken charge by the Center for Ozone Layer Protection. One of the targets of the task is to calculate the greenhouse gas emissions factor of the power supply to the existing Vietnam electricity grid for 2005, 2006, 2007 and 2008 to serve the state management on the national power system and simultaneously meet the demand of developing the Clean Development Mechanism (CDM) projects by domestic consultants.

Scope of Application: To apply uniformly to the implementation of projects replacing electricity from the grid (electricity grid, using power-saving net ...) under the CDM in Vietnam.

The Grid of the power system which is determined to calculate the emission factor is the scope of the power grid, including transmission and distribution lines connecting to the existing power plants (sell electricity to the grid).

I. Methodology

The Methodology is applied under the guidance of the Framework Convention of the United Nations on Climate Change (UNFCCC) on "Tool to calculate emission factor for electricity system", in which the CO_2e emission factor of fuel is taken by the IPCC default values as in Table 14. It is needed to concern that this version is the latest update that the process of collecting data and calculating EF is implemented, that is in 2009.

Table 14: CO_2 emission factor according to IPCC

Fuel Type	Default Carbon Content (kg/GJ)	Default Carbon Oxidation Factor	Emission factor CO2 (kg/TJ)		
			Default Value	95% Confidence interval	
				Lower	Upper
Gas/Diesel DO	20.2	1	74,100	72,600	74,800
Fuel FO	21.1	1	77,400	75,500	78,800
Anthracite Coal	26.8	1	98,300	94,600	101,000
Bitum Coal types	25.8	1	94,600	89,500	99,700
Natural Gas	15.3	1	56,100	54,300	58,300

Sources: IPCC

The calculation of emission factor for the existing grid belonging to the National electricity system based on above document with carefully review on the instructions and accompanied conditions, while it based on existing and collectable data sources in Vietnam to apply reasonably, validly and most appropriately. This methodology is used to calculate the CO_2e emission factor for the change of generated power produced by power plants in the electricity system by calculating the Operating margin (OM) and Build margin (BM) then Combined Margin (CM).

OM includes all existing power plants in the electricity system, the output of existing power plants will be affected by the CDM project activity. Meanwhile, BM is associated with a group of power plants of which the construction will be affected by the CDM project activity.

Table 15: Parameters need calculation

Parameters	SI Units	Description
$EF_{grid,CM,y}$	tCO_2e/MWh	Combined margin emission factor for the project electricity system in year y
$EF_{grid,BM,y}$	tCO_2e/MWh	Build margin emission factor for the project electricity system in year y
$EF_{grid,OM,y}$	tCO_2e/MWh	Operating margin emission factor for the project system in year y

I.1. Determine the Operating Margin (OM) emission factor

The calculation of the Operating Margin emission factor is based on one of the following methods:

(a) Simple OM (OM_{simple}); or

(b) Simple adjusted OM ($OM_{simple\ adjust}$); or

(c) Dispatch data analysis OM ($OM_{dispatch\ data}$); or

(d) Average OM ($OM_{average}$).

Any of above four methods can be applied; however ,in the condition of Vietnam, the Simple OM method (OM_{simple} – option a) will be chosen because the output of Low cost – Must run power stations constitute less than 50% the 5 years- average output of the whole electricity system, as below:

Table 16: Low-cost/must-run Power Ratio

Year	2004	2005	2006	2007	2008	5 year average value
Hydropower (MWh)	17,858,651	16,365,438	19,508,244	22,385,232	25,933,762	**102,051,327**
Total power (MWh)	44,974,169	50,330,468	57,160,493	66,348,589	74,689,636	**293,503,355**
Low-cost/Must-run Power Ratio	39.71%	32.52%	34.13%	33.74%	34.72%	**34.77%**

The simple OM emission factor is calculated as below:

$$EF_{grid,OM_{simple},y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,OM,y}$	is the Simple operating margin CO_2 emission factor in year *y* (tCO_2/GWh)
$EG_{m,y}$	is the net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (GWh)
$EF_{EL,m,y}$	is the CO_2 emission factor of power unit *m* in year *y* (tCO_2/GWh)
m	All power plants/units serving the grid in year *y* except low-cost/must-run power plants/units
y	Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option)

I.2. Determine the Build Margin (BM) emission factor

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

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

Where:

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

I.3. Calculate the Combined Margin emission factor CM

The CM emissions factor is calculated as follows:

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

Where:

w_{OM}	Weighting of OM emissions factor (%)
w_{BM}	Weighting of BM emissions factor (%)

For the proposed project, the following default values are used: w_{OM} = 0.5 and w_{BM} = 0.5 in the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 in the second and third crediting period.

II. Calculate the Define the Emission factor (EF)

II.1. Vietnam grid-connected power generation

Table 17: Output of power plants (2004-2008)

Unit: MWh

Plant	2004	2005	2006	2007	2008
Hydropower	17,859	16,365	19,508	22,385	25,934
Coal-fired	6,500	7,872	8,989	9,836	10,055
Oil-fired	19,053	24,017	26,543	29,475	33,857
Gas Turbine	1,379	1,612	1,044	1,834	1,482
Diesel FO	68	50	80	105	90
Diesel DO	43	16	25	42	15

Biomass	34	26	34	42	36
Import	39	373	937	2,629	3,220
Total domestic electricity	44,936	49,958	56,223	63,719	71,469
Total domestic electricity + Import	44,975	50,331	57,160	66,348	74,689

Source: Report of power plants under the Vietnam electricity system according to document no CV4680/BCT NL2009 and document No. CV 7533/BCT-NL to Ministry of Resources and Environment), 7/2009.

II.2. Calculate the emission factor of Vietnam electricity system

II.2.1. Calculate the OM emission factor in 2008

The OM emission factor in 2008 is based on the total emission and the total power output in the most recent 3 years (2006-2008), as below:

Table 18: Fuel consumed, emissions and output in the most recent 3 years (2006, 2007, 2008)

Plants	Fuel consumed (Coal, Oil: kton Gas: mm3)	Grid connected output (MWh)	Emissions (tCO2e)
2006			
Coal-fired	5,645.86	8,989,230.00	11,823,610.00
Gas-Turbine		26,542,978.00	12,479,578.00
Gas-Turbine-gas	*5,743,253.28*	*18,838,764.00*	*12,244,651.00*
Gas-Turbine-oil	*70.14*	*233,582.00*	*234,927.00*
Gas-stem	*0.00*	*7,470,632.00*	*0.00*
Oil-fired	397.65	1,043,991.00	1,327,593.00
Diesel FO	16.60	80,000.00	51,642.00
Diesel DO	6.39	25,000.00	20,495.00
Import		937,000.00	0.00
Total		**37,618,199.00**	**25,702,918.00**
2007			
Coal-fired	6,386.09	9,836,548.00	13,272,897.00
Gas-Turbine		29,474,918.00	13,116,063.00
Gas-Turbine-gas	*5,910,941.84*	*20,023,591.00*	*12,570,559.00*
Gas-Turbine-oil	*163.27*	*557,880.00*	*545,394.00*
Gas-stem	*0.00*	*8,893,447.00*	*0.00*
Oil-fired	614.06	1,834,409.00	2,046,368.00
Diesel FO	25.15	104,626.00	79,867.00
Diesel DO	9.16	42,000.00	29,088.00
Import		2,629,000.00	0.00
Total		**43,921,501.00**	**28,544,283.00**
2008			

Coal-fired	6,483.99	10,055,394.00	13,378,811.00
Gas-Turbine		33,857,135.00	14,716,799.00
Gas-Turbine-gas	*6,839,114.84*	*22,396,231.00*	*14,535,266.00*
Gas-Turbine-oil	*54.35*	*183,088.00*	*181,533.00*
Gas-stem	*0.00*	*11,277,816.00*	*0.00*
Oil-fired	534.59	1,481,880.00	1,784,825.00
Diesel FO	22.48	90,465.00	71,385.00
Diesel DO	3.73	15,000.00	11,879.00
Import		3,220,000.00	0.00
Total		**48,719,874.00**	**29,963,699.00**

Table 19: Total emission and power output of the most recent 3 years

	2006	2007	2008	Total
Total output (MWh)	37,618,199.00	43,921,501.00	48,719,874.00	**130,259,574.00**
Total Emission (tCO2e)	25,702,918.00	28,544,283.00	29,963,699.00	**84,210,900.00**

Table 18: OM emission factor in 2008

Year	Total output (MWh)	Total emission (tCO2e)	OM 2008 (tCO2e/MWh)
	A	B	(ΣB/ΣA)
2006	37,618,199.00	25,702,918.00	
2007	43,921,501.00	28,544,283.00	
2008	48,719,874.00	29,963,699.00	
Total	**130,259,574.00**	**84,210,900.00**	**0.6465**

II.2.2. Calculate the Building Margin emission factor in 2008

The total output of Vietnam electricity grid in 2008 is 74,689,635.97 MWh

20% of the total output of Vietnam electricity grid in 2008 is 14,937,927.19 MWh

Table 20: Calculate the BM emission factor in 2008

Plant	Comission year	Fuel consumed (Coal, Oil: kton Gas: mm3)		Grid connected output (MWh)	Emissions (tCO2e)
5 most recent - built plants					
A Vuong	2008	Hydropower		168,103.50	
Tuyen Quang	2008	Hydropower		1,136,112.18	
Dai Ninh	2008	Hydropower		1,145,108.50	
Nhon Trach	2008	Gas	166.38	544,808.60	378,023.00
Ca Mau 1&2	2007	Gas	647.24	2,106,807.24	1,431,048.00
		Gas-stem		2,728,872.00	
Total				**7,829,812.02**	
Most recent-built plants charged 20% total output					
A Vuong	2008	Hydropower		168,103.50	

SROC Phu Mieng IDICO	2006	Hydropower		241,556.00	
SE SAN 3A	2006	Hydropower		394,895.70	
Tuyen Quang	2008	Hydropower		1,136,112.18	
Dai Ninh	2008	Hydropower		1,145,108.50	
SE SAN 3	2006	Hydropower		1,131,614.00	
Quang Tri	2007	Hydropower		250,804.40	
Uong Bi 2	2007	Coal	281.76	532,000.00	581,017.63
Na Duong	2005	Coal	532.00	627,930.00	883,846.37
Cao Ngan	2007	Coal	526.00	708,693.00	1,081,145.84
Formosa	2004	Coal	495.00	560,295.00	1,291,302.96
Nhon Trach	2008	Gas	166.38	544,808.60	378,023.07
Ca Mau 1&2	2007	Gas	647.24	2,106,807.24	1,431,047.61
		Gas-stem		2,728,872.00	
Phu My 2,2	2004	Gas	1,159.75	4,141,980.00	2,510,751.14
Dam Phu My	2006	Gas	56.15	4,716.00	133,868.48
Cai Lan - VINASHIN	2007	FO	22.48	90,465.01	71,384.99
Total				**16,514,761.12**	**8,362,388.09**

II.2.3. Emission Factor EF (Combined Margin –CM) 2008

Table 21: Calculate the BM emission factor in 2008

	Weighed	Emission Factor (tCO2e/MWh)
OM	0.5	0.6465
BM	0.5	0.5064
CM (EF)		**0.5764**

III. Conclusion

The Emission factor of Vietnam Electricity system in 2008 is 0.5764 tCO_2e/MWh.

Comparing to the past years the EF of 2008 has considerably been reduced because the BM emission factor has decreased faster than the OM. The reason is many hydropower plants have been started operation recently.

The trend of emission reduction is due to 2 main reasons:

(i) The imported power increased from 39 million kWh in 2004 to 322 billion kWh in 2008;

(ii) Power from hydropower plants increased more rapidly than from coal –fired plants.

This is the results calculated based on the most updated official data sources that compliance with the guidance of the methodology used to calculate the emission of greenhouse gases to the system version number 2.2.0under UNFCCC.

The calculation of emission of the grid is continual as the research should be updated with data implemented annually.

ANNEX 4

MONITORING INFORMATION

A. Description of technical equipment

The metering system will be installed at the connecting point. They are digital meters bi-directly with the accuracy of at least 0.5s and 0.2s for back-up system and main system respectively or subject to the relevant laws of the host country. The metering system includes the main system and a back-up system.

The meter type used is an electronic 3 phase and details on the technical equipment can be found in the technical designing report as developed by the project proponent. The following figure mentions the position of installed meter at the connected point.

B. Monitoring organization

The structure of the monitoring group is as follows:

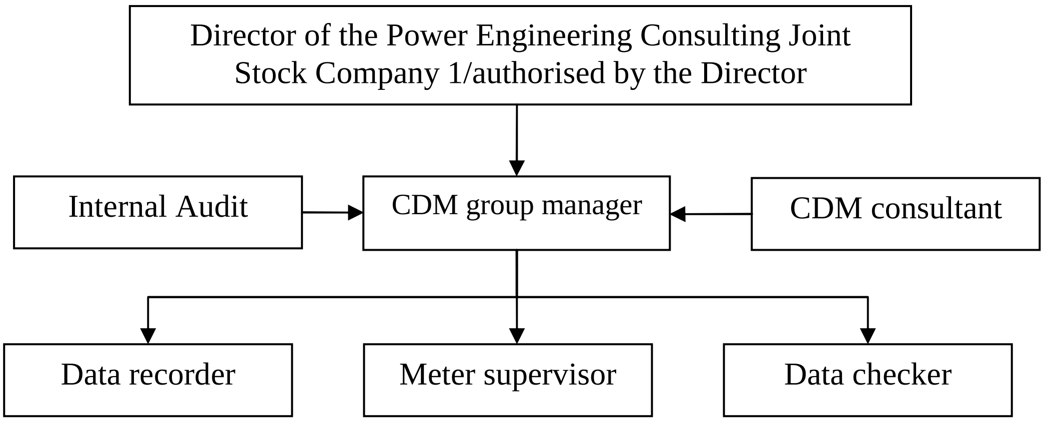

Figure 4: Structure of the monitoring group

The responsibilities of each person involved are elaborated as follows:

Group members and their responsibilities

Person	Responsibility
Director of Power Engineering Consulting Joint Stock Company 1/authorised by the Director	Check and sign the monitoring report annually.
CDM group manager	Managing the whole CDM business of Song Bung 5 hydropower plant, guiding and supervising data recorder after trained by CDM consultant.
CDM consultant	Providing CDM group manager training and technical support about CDM monitoring plan.
Internal auditor	Check the monitoring procedure at least once in a year.
Data recorder	Collecting and recording data every month.

Meter supervisor	Checking power meter periodically according to relevant regulation.
Data checker	Double checking the collected data measured by power meter.

C. Monitoring procedure

The steps of monitoring the electricity supplied to the grid and the electricity imported from grid and consumed by the proposed project are as follows:

(1) The electricity supplied by the project to the grid will be automatically monitored by the two meter systems (main and backup). The data is measured continuously.

(2) Persons in charge of data record and meter supervisor from Song Bung 5 hydropower plant together with staff from EVN shall read and collect data from main power meters and backup power meters at the end of every month, the result or the joint balance sheet will be signed by both parties and kept respectively;

(3) Song Bung 5 hydropower plants provide electricity sales invoice to EVN, and keeps the copy of invoice.

(4) Power Engineering Consulting Joint Stock Company 1 shall hire the third party for measuring the surface area of reservoir at the normal water level annually.

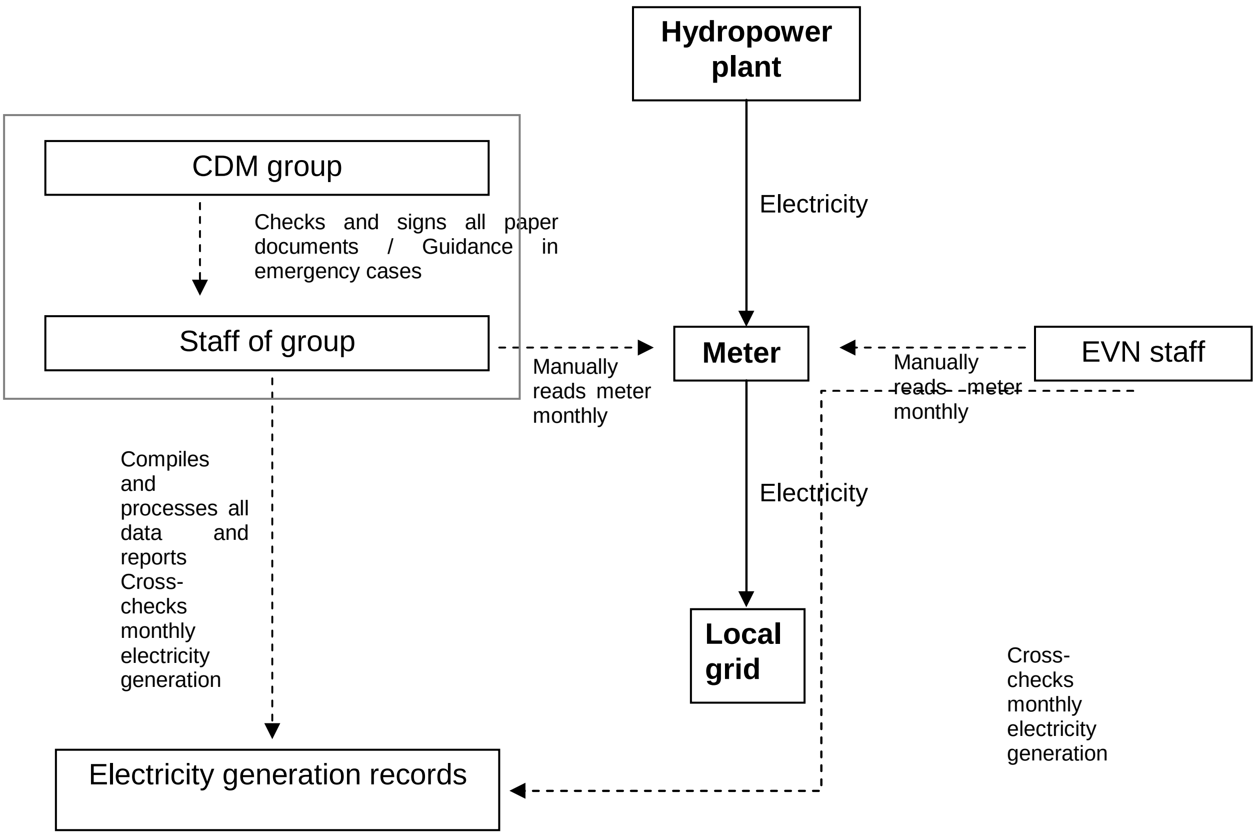

Figure 5: Monitoring process

D. Calibration of metering equipment

Before on-site installation meters will be calibrated and verified by a third party pursuant to the Decision No 65/2002/QD-BKHCNMT[33]. According to this Decision, calibration and verification for 3 phase meters need to be conducted every second year. This means that calibration will be undertaken by the third party once in every two-year period during project operation. The third party will after every calibration seal the meters so that no interference is possible.

E. Data recording and archiving procedures

- The CDM group appointed by Song Bung 5 hydropower plant shall keep monitored data in electronic archives at the end of every month. Paper documents should be stored in electronic format and copied by CD. Electronic documents should be printed out and kept.
- Song Bung 5 hydropower plant shall keep the copy of electricity sales/purchase invoices (the original electricity sales/purchase invoices shall be kept by Finance Department of Power Engineering Consulting Joint Stock Company 1).
- In order to help verifiers obtain documents and information related to the emission reduction of the proposed project, Power Engineering Consulting Joint Stock Company 1 shall prepare an index of the data documents and monitoring report.
- All the data and information in the form of paper documents shall be archived by the CDM group, with at least one copy backup for each datum.
- All the data shall be kept for 2 years after the crediting period.

F. Emergency procedures

In case of any unforeseen event that is not covered under this monitoring plan, staff of the CDM group shall inform the manager and the director. The manager and director are then responsible to ensure that the cause for the unforeseen event is detected, the event is remedied and for the period of time in which the unforeseen event has occurred uncertainty in data gathered is limited as much as possible.

In the case the error of main meter exceeds allowed level the backup meter will be used to measure output of electricity exporting to grid.

In case of both main and back-up metering systems are in failure, the project owner and the power company (EVN) will jointly calculate a conservative estimate of power supplied to the grid. The assumptions used to estimate net electricity supply to the grid will be signed by both a representative of the project owner as well as a representative of the power company (EVN).

G. Training

VNEEC will in close collaboration with the chief of the operation division of the power plant develop a training manual and training course for the staff of the operation division that will clearly lay out rules and procedures for all activities related to metering, data recording and processing, data archiving and preparation of monitoring reports.

[33] Decision No 65/2002/QD-BKHCNMT[33] issued by the Minister of Science, Technology and Environment on 19 August 2002 promulgating "The list of meter equipment must be calibrated and verified and the verification procedures".