MONITORING REPORT
OF
SONG ONG HYDROPOWER PROJECT

Document Prepared by Energy and Environmental Consultancy Joint Stock Company

Project Title	Song Ong Hydropower Project	
Version	2.1	
Date of Issue	29 March 2012	
Project ID	4117	
Monitoring Period	24 March 2009 to 28 February2011 (inclusive both dates)	
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1 PROJECT DETAILS

1.1 Summary Description of Project

Song Ong Hydropower Project is located on Ong River in Quang Son commune, Ninh Son district in Ninh Thuan province of Vietnam. The projects installed capacity and estimated annual gross power generation are 8.1 MW and 40,500 MWh, respectively.

The project activity involves the construction of a dam, an intake, tunnels, a penstock, a pressurized well, a power house with 03 units and a discharge channel in order to convert potential flowing energy from the stream into clean electrical energy.

The construction of Song Ong Hydropower plant was started in late of 2005 and commission in March 2009. On 05 March 2009, the plant test run was started and the plant started supplying electricity to the national grid on 24 March 2009.

Song Ong Hydropower project was registered as a Clean Development Mechanism (CDM) project on 04 February 2011 with the Project Design Document (PDD) version 2.5 dated 02 November 2010 and the registered number of 4117[1]. However, the start date of the first CDM crediting period is 01 March 2011, therefore, the project participants choose the first crediting period for Voluntary Emission Reductions (VCS) from the date of commissioning until 28 February 2011.Thus, the period from 24th March 2009 to 28 February 2011 is claimed for the VCS emission reduction crediting.

The project activity generates renewable power with negligible Greenhouse Gas (GHG) emissions, which displaces part of the electricity otherwise supplied by fossil fuel fired power plants. The monthly reading protocol signed between the project owner and the EVN is the main data source and serves as evidences for calculation of emission reduction. The estimated annual CO_2 emission reduction of the project is 21,416 tCO2.

During the pre-registration period from the commissioning date to the registered date, Song Ong Hydropower project did not participate to any Environmental Credit Scheme.

This monitoring report has been prepared in accordance with the monitoring plan contained in the registered PDD, which is registered monitoring plan for the CDM project. The PDD will serve as the basis for the verification, certification and issuance of the emission reductions during the monitoring period indicated above.

1.2 Sectoral Scope and Project Type

Sectoral scope : 01. Energy industries (renewable - /non-renewable sources)

Project Type : I. Renewable energy project

Project Category: I.D. Grid connected renewable electricity generation – Version 16

1.3 Project Proponent

[1] http://cdm.unfccc.int/Projects/DB/RWTUV1289918487.21/view

Song Ong Hydropower Joint Stock Company – the project owner of Song Ong Hydropower Project

Address	: Quang Son commune, Ninh Son district, Ninh Thuan province, Viet Nam
Telephone	: +84 683 851 556
Represented by	: Mr. Nguyen Hai Quynh
Email	: thuydienso@yahoo.com.vn

Swiss Carbon Value Ltd., - the VER Buyer of Song Ong Hydropower Project

Address	: Technoparkstr.1 8005 Zurich, Switzerland
Telephone	: + 41 43 501 3550
Represented by	: Mr. Renat Heuberger
Email	: registration@southpolecarbon.com

1.4 Other Entities Involved in the Project

Energy and Environment Consultancy Joint Stock Company - the Consultant for VER project of Song Ong project

Address	: Room 1210, 18T2 Building, Le Van Luong Street, Trung Hoa – Nhan Chinh residential area, Hanoi.
Telephone	: +84 4 2214 8810
Fax	: +84 4 6281 2733
Represented by	: Ms Dang Thi Hong Hanh
Email	: eec@eec.vn

1.5 Project Start Date

24 March 2009.

This was the date when Song Ong hydropower plant started to supply electricity to Vietnam national grid.

1.6 Project Crediting Period

Start date of crediting period: 24 March 2009 (inclusive)

End date of crediting period: 28 February 2011 (inclusive)

Total number of year in the first crediting period: 1 year 11 months

Song Ong Hydropower project was registered as a Clean Development Mechanism (CDM) project on 04 February 2011 with the PDD version 2.5 dated 02 November 2010 with the first CDM crediting period started on 01 March 2011. Thus, the project participants choose the first crediting period for Voluntary Emission Reductions (VCS) from the date of commissioning until 28 February 2011. Therefore, the period from 24 March 2009 to 28 February 2011 is claimed for the emission reduction in the first crediting period for VCS.

1.7 Project Location

Song Ong Hydropower project is located on Ong river in Quang Son commune, Ninh Son district in Ninh Thuan province.

The geographic coordinate of the dam and water intake of the project as below:

Project	Song Ong hydropower project	
	Latitude	Longitude
Water intake	$11^0$45'13''	$108^0$48'19''
Power house	$11^0$44'56''	$108^0$49'20''

The site of the project is shown in Figure 1.

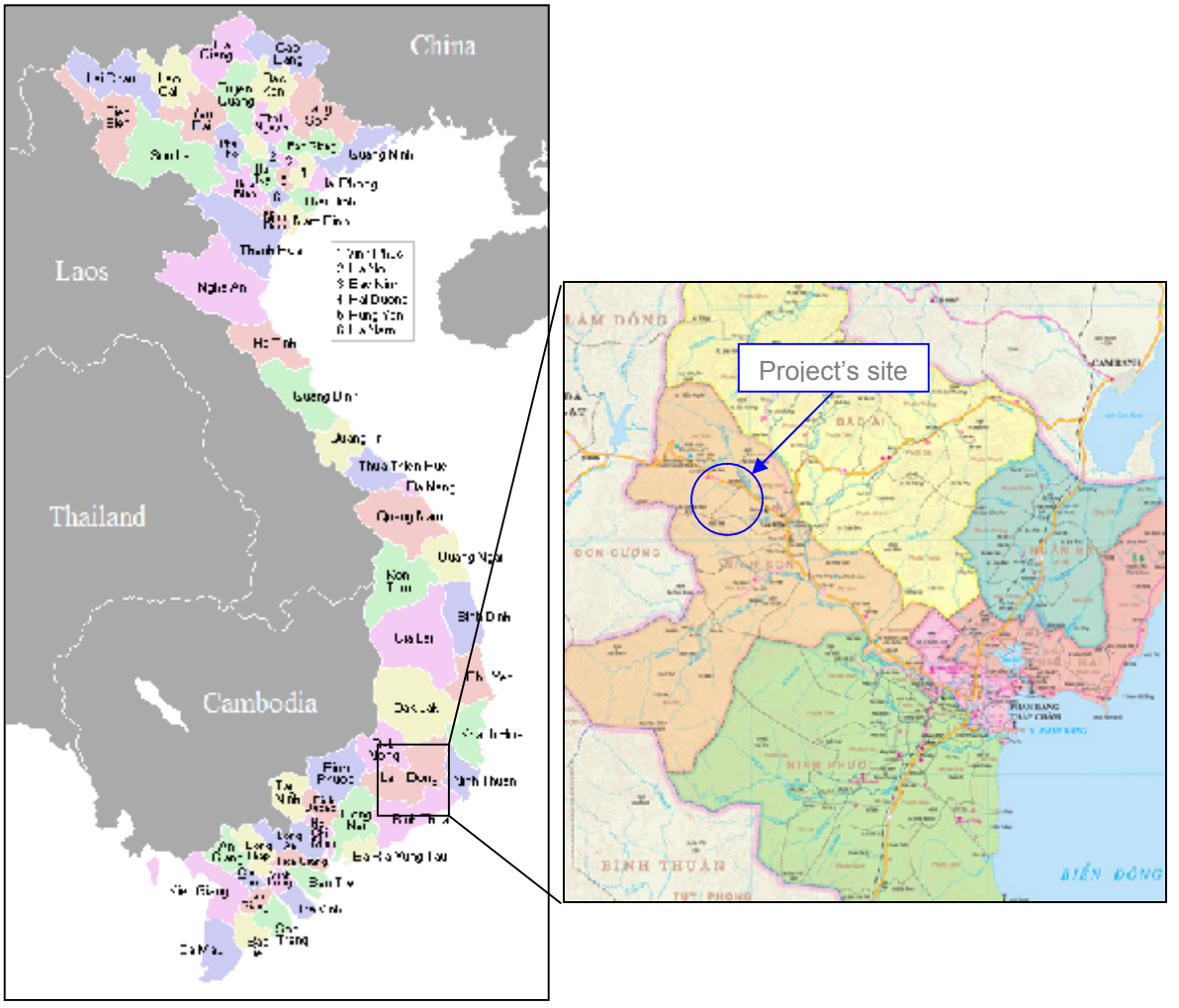

Figure1. Project site on map

The lay-out of project is shown below:

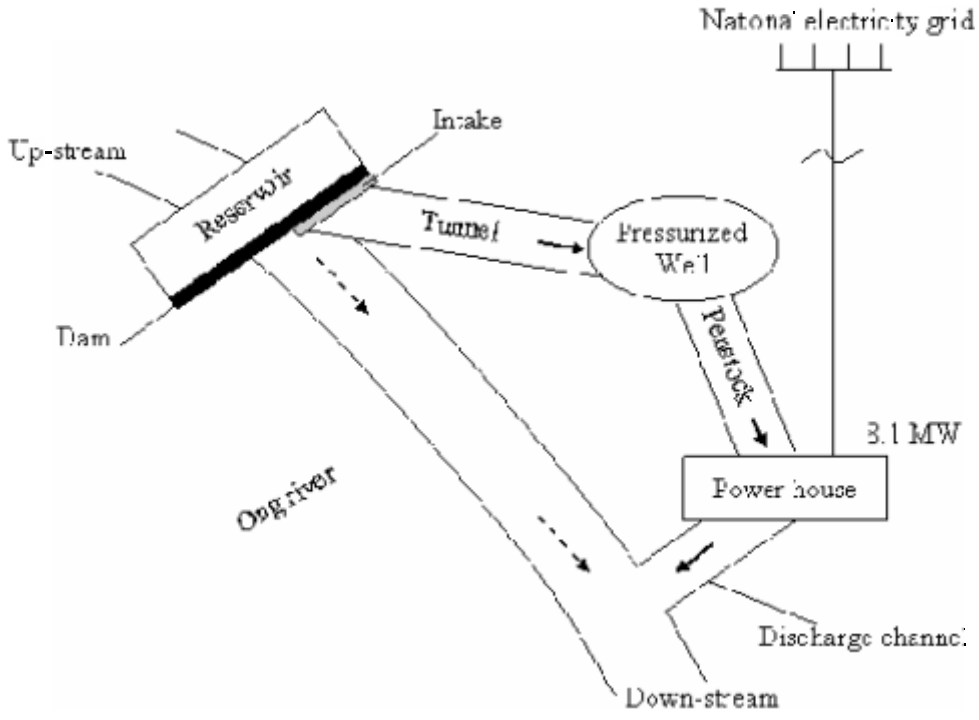

Figure 2: Song Ong project's lay-out

1.8 Title and Reference of Methodology

The monitoring methodology AMS – I.D "Grid connected renewable electricity generation" – Version 16 was applied for the project.

Besides, the following subscribed tools were applied:

- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion version 02
- Tool to calculate the emission factor for an electricity system version 02

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

Song Ong Hydropower plant started operating on 24 March 2009. During the first crediting period (from 24 March 2009 to 28 February 2011), an emergency case occurred on 05 August 2009.

A brief description of:

- Events or situations that occurred during the monitoring period, which may impact the applicability of the methodology: From 24 March 2009 to 04 August 2009, the plant had been in a stable operation state. On 05 August 2009, an emergency occurred and the plant had to stop the operation. The reason was the short circuit, which caused electric discharge, which consequently caused the cables to be damage. The Song Ong hydropower plant was repaired and the unit no.01 and 02 restarted operating on 08 September 2009. Song Ong Hydropower plant has been reconnected to national grid since then. The unit no.03 only resumed operating and Song Ong Hydro power plant was considered completely repaired on 17 December 2009. Since the reconnection to the grid, the hydropower plant has been operating stably and all the

electrical and mechanical components have been in good state. There was no more failure in the monitoring period.

- How the issues resulting from these events or situations are being addressed: In the operating plant process, the hydropower plant is being checked by the operator at each shift.

2.2 Deviations from the Monitoring Plan

There is no deviation from the monitoring plan in the registered Project Design Document.

2.3 Grouped Project

Not applicable

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data Unit / Parameter:	**Cap_{BL}**
Data unit:	MW
Description:	Installed capacity of hydropower plant before the implementation of the project activity.
Source of data:	This is a newly constructed power plant. This value does not exist prior to the implementation of the project activity
Value applied:	0
Purpose of the data:	For calculating the power density (PD)
Any comment:	The project activity constructs a new hydropower plant, so Cap_{BL} is considered by zero

Data Unit / 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:	This is a newly constructed power plant. This value does not exist prior to the implementation of the project activity
Value applied:	0
Purpose of the data:	For calculating the power density (PD)
Any comment:	The project activity builds a new reservoir, so A_{BL} is considered by zero.

Data Unit / Parameter:	**Heat rate**
Data unit:	kcal/kWh

Description:	Heat rate of each power plant or the energy conversion
Source of data:	Data supplied by EVN
Value applied:	Value applied in Annex 1
Purpose of the data:	For calculation of EF_{OM} or EF_{BM}
Any comment:	When establishing the baseline, the local or actual data for the plants in calculation is provided by EVN and then endorsed by the Vietnam DNA.

Data Unit / Parameter:	$\mathbf{EG_{m,y}}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant/unit m in year *y*
Source of data:	Data supplied by EVN
Value applied:	Value applied in Annex 1
Purpose of the data:	For calculation of EF_{OM} or EF_{BM}
Any comment:	Dispatch data is not disclosed by the Government of Vietnam. EVN provides the most actually updated data relevant to the power generation in Vietnam that could be accessed by public. And this data source is recommended by DNA Vietnam

Data Unit / Parameter:	$\mathbf{EF_{CO2,i,y}}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data:	Default value of the IPCC 2006 Guidelines
Value applied:	Value applied in Annex 1
Purpose of the data:	For calculation of EF_{OM} or EF_{BM}
Any comment:	With reference to Version 1.1 of "Tool to calculate the emission factor for an electricity system"

Data Unit / Parameter:	$\mathbf{NCV_{i,y}}$
Data unit:	TJ/Gg
Description:	Net calorific value (energy content) of diesel in year *y*
Source of data:	IPCC default value
Value applied:	43.3
Purpose of the data:	For calculation of $PE_{FFj\,y}$
Any comment:	With reference to Version 2.0 of "Tool to calculate project of leakage CO_2 emissions from fossil fuel combustion" report annex 11, EB4

Data Unit / Parameter:	**$EF_{CO2,diesel,y}$**
Data unit:	kgCO2/TJ
Description:	CO_2 emission factor of diesel in year *y*
Source of data:	IPCC default value
Value applied:	74,800
Purpose of the data:	For calculation of $PE_{FFj\,y}$
Any comment:	With reference to Version 02 of "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" version 02, report annex 11, EB41

3.2 Data and Parameters Monitored

Data Unit / Parameter:	**$EG_{y,export}$**
Data unit:	MWh
Description:	Electricity supplied by the hydropower plant to the national grid
Source of data:	Direct measurement at the connection point
Description of measurement methods and procedures to be applied:	Two-way power meters were installed at the grid-connected point to measure the amount of electricity supplied to the grid by the project in the positive direction. The readings of electricity meter has been hourly measured and monthly recorded. The recorded data has been confirmed in 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 till 2 years after the end of the crediting period.
Frequency of monitoring/recording:	Continuous monitoring, hourly measurement and monthly recording
Value monitored:	77,042.5
Monitoring equipment:	Main power meter and Back-up power meter: • Manufacturer: ELSTER • Model: PB3KAAGHT-5 • Serial number: 08062733, 08062734 • Accuracy (active energy): 0.5s
QA/QC procedures to be applied:	Both power meters are to be calibrated at least once every 2 years by a qualified third party. Details provided in section 3.3.5
Calculation method:	
Any comment:	For calculation $EG_{BL,y} = EG_{y,\,export} - EG_{y,\,import}$

Data Unit / Parameter:	**$EG_{y,import}$**

Data unit:	MWh
Description:	Electricity supplied by the national grid to the proposed hydropower plant
Source of data:	Direct measurement at the connection point
Description of measurement methods and procedures to be applied:	Two-way power meters were installed at the grid-connected point to measure the amount of electricity supplied to the grid by the project in the positive direction. The readings of electricity meter has been hourly measured and monthly recorded. The recorded data has been confirmed in the joint balance sheet, which is signed by the representatives of EVN and the project owner. Electronic data will be archived within the crediting period till 2 years after the end of the crediting period.
Frequency of monitoring/recording:	Continuous monitoring, hourly measurement and monthly recording
Value monitored:	1.3
Monitoring equipment:	Main power meter and Back-up power meter: • Manufacturer: ELSTER • Model: PB3KAAGHT-5 • Serial number: 08062733, 08062734 • Accuracy (active energy): 0.5s
QA/QC procedures to be applied:	Both power meters have been calibrated at least once every 2 year by a qualified third party. Details provided in section 3.3.5
Calculation method:	
Any comment:	For calculation $EG_{BL,y} = EG_{y,\ export} - EG_{y,\ import}$

Data Unit / Parameter:	**$EG_{BL,y}$**
Data unit:	MWh
Description:	Net electricity supplied to the national grid by the proposed hydropower plant
Source of data:	Calculated from $EG_{y,\ import}$ and $EG_{y,\ export}$
Description of measurement methods and procedures to be applied:	Calculating by subtracting $EG_{y,import}$ from $EG_{y,export}$. Data shall be archived within the crediting period and 2 years after the end of the crediting period.
Frequency of monitoring/recording:	Continuous monitoring and monthly recording
Value monitored:	77,041.2
Monitoring equipment:	The data is calculated based on electricity exported to the grid and electricity imported from the grid.
QA/QC procedures to be applied:	The sales receipts can be used for double check of the data. The meters have been calibrated every two years by a qualified third party.
Calculation method:	$EG_{BL,y,} = EG_{y,\ export} - EG_{y,\ import}$

Any comment:	Sale and purchase invoices of electricity to the grid are used to ensure the consistency.

Data Unit / Parameter:	A_{PJ}
Data unit:	m^2
Description:	Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full
Source of data:	Project site
Description of measurement methods and procedures to be applied:	Area of the reservoir measured in the surface of the water, after the implementation of the project activity when the reservoir is full.
Frequency of monitoring/recording:	Yearly
Value monitored:	Year: Area (m^2) 2009: 17,464 2010: 17,448
Monitoring equipment:	Measured from the topographical surveys, maps, satellite pictures
QA/QC procedures to be applied:	The area has been measured by a qualified third party
Calculation method:	
Any comment:	For power density calculation

Data Unit / Parameter:	Cap_{PJ}
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity.
Source of data:	Aggregated from the Manufacturer's nameplate at the project site
Description of measurement methods and procedures to be applied:	This parameter is checked directly in the project site
Frequency of monitoring/recording:	Yearly
Value monitored:	8,100,000
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	

Any comment:	Use for calculating the power density

Data Unit / Parameter:	$FC_{i,j\,y}$
Data unit:	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description:	The quantity of fuel type i combusted in process j during the year y in the event of black out of the plant
Source of data:	Onsite measurements
Description of measurement methods and procedures to be applied:	Continuously if backup system is used. Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be an integral part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift)
Frequency of monitoring/recording:	Yearly
Value monitored:	333.87 liter
Monitoring equipment:	The recorded data in the log book and purchase invoices
QA/QC procedures to be applied:	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Calculation method:	Use for calculating $PE_{FF,y,l}$
Any comment:	

3.3 Description of the Monitoring Plan

3.3.1 Describe the Monitoring Plan

The baseline emission factor of Vietnam National Grid ($EF_{grid,CM,y}$) is fixed ex-ante, the main data to be monitored is EG_{BLy}. EG_{BLy} is calculated according to this formula below:

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

The electricity generated from the project activity is 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 is measured by a digital kilowatt hour (kWh) meter. The metering system includes the main system and a back-up system. The back-up system is used in case of failing of the main meter.

Data from the operating meters is recorded hourly. Additionally, monthly manual readings are taken from the operating meters.

Monthly, EVN staff and staff of the operation division of the power plant 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.

When the electricity generation from the plant is cut off, a backup generator with installed capacity of 250KVA to generate electricity will be used internally within the plant. In such case, the CDM team will keep all relevant records for verification purposes.

a) Description of technical equipment

The metering system was installed at the connecting point in 110kV Ninh Son Station. They are digital meters bi-directly with the accuracy of 0.5 S. 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 hard copy document "Technical explanation for metering system" as developed by the project proponent and approved by EVN. The following figure mentions the position of installed meter equipment as the connected point.

b) Monitoring organization

The structure of monitoring group is as follows:

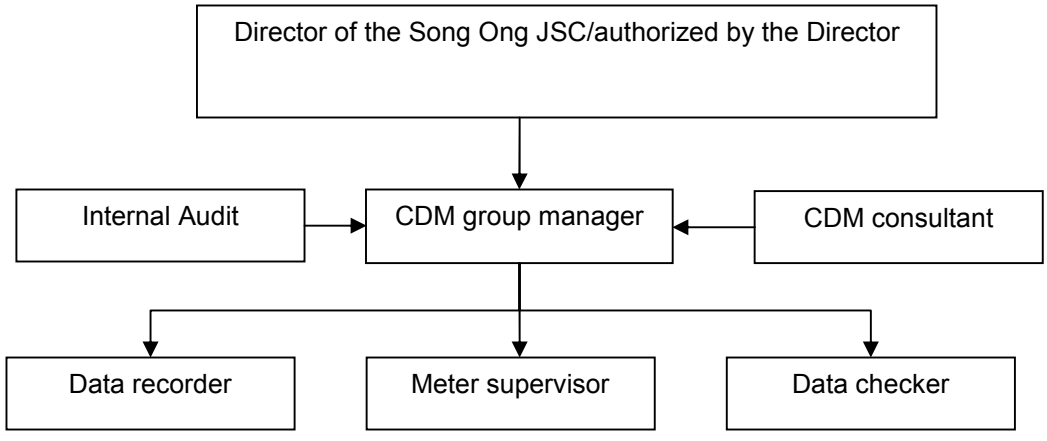

Figure 3: Structure of the monitoring group

The responsibilities of each person involved are elaborated as follows:

Group members and their responsibilities

Person	Responsibility
Director of the Song Ong JSC/authorized by the Director	Check and sign the monitoring report annually
CDM group manager	Managing the whole CDM business of Song Ong power 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 project are as follows:

(1) Persons in charge of data record and meter supervisor from Song Ong power plant together with staff from EVN read and collect data from main power meters on the first day of every month, the result is signed by both parties and kept respectively;

(2) The data from the backup power meter is hourly recorded by the person in charge of data recording at Song Ong hydropower plant. This recorded data is cross-checked with the data from main power meter. Data is filled in the form provided by VNEEC.

(3) Song Ong hydropower plant provides electricity sales invoice to EVN, and keeps the copy of invoice;

(4) Song Ong hydropower plant provides the record of main, backup power meters and copy of invoices to the verifier of DOE.

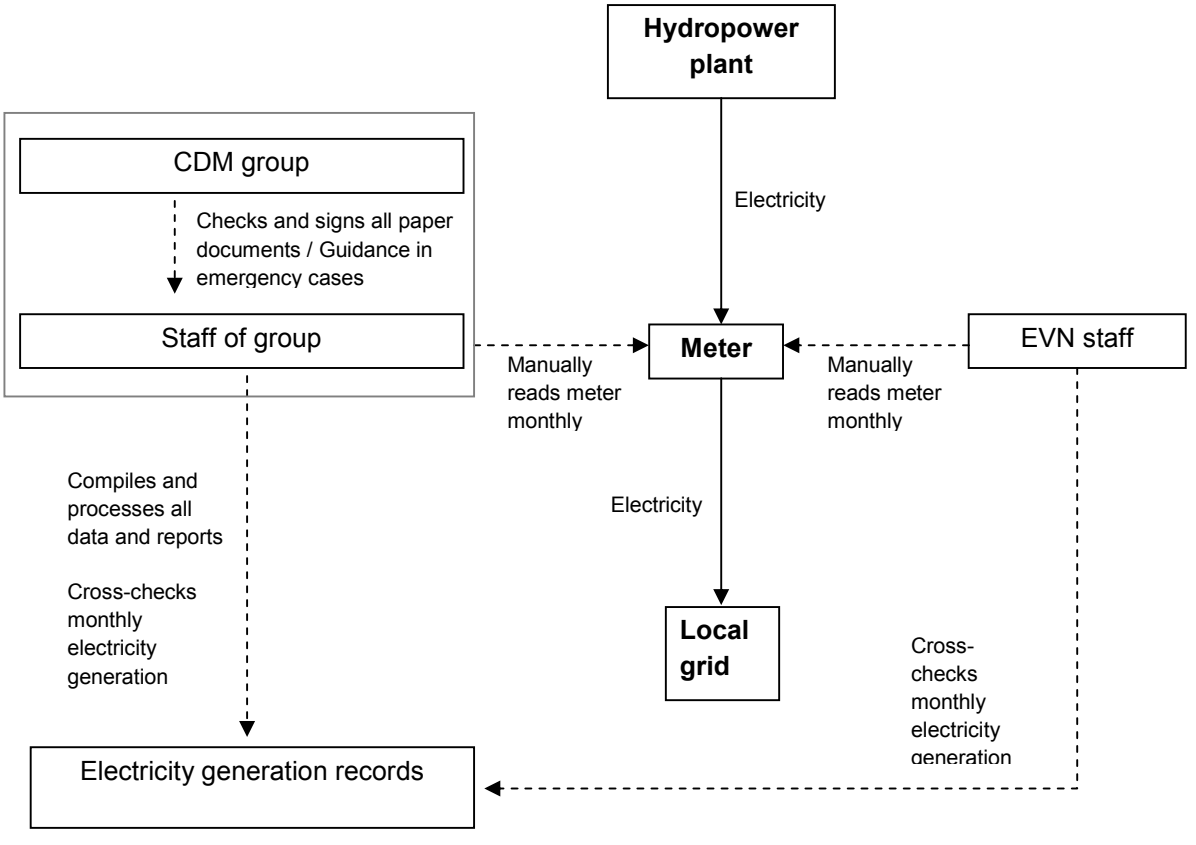

Figure 4: Monitoring process

d) Calibration of metering equipment

Before on-site installation meters were calibrated and verified by local STAMEQ pursuant to the Decision No 65/2002/QD-BKHCNMT[2]. According to this Decision, calibration and verification for 3 phase meters need to be conducted every second year. This means that calibration is undertaken by

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

local STAMEQ once in every two-year period during project operation. After every calibration, local STAMEQ seals the meters so that no interference is possible.

e) Data recoding and archiving procedures

- The CDM group appointed by Song Ong power plant keeps monitored data in electronic archives at the end of every month. Paper documents are stored in electronic format and copied by CD. Electronic documents are printed out and kept.
- Song Ong power plant keeps the copy of electricity sales/purchase invoices (the original electricity sales/purchase invoices are kept by Finance Department of Song Ong Hydropower JSC).
- In order to help verifiers obtain documents and information related to the emission reduction of the project, Song Ong Hydropower JSC prepares an index of the data documents and monitoring report.
- All the data and information in the form of paper documents are 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 operation division will immediately inform the chief of the operation division. The chief of the operation division is 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 doing so, the chief of division shall seek guidance from VNEEC.

g) Training

Before the start of the crediting period, VNEEC in closes 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.

3.3.2 Identify organizational structure, responsibilities and competencies

The Project owner of Song Ong hydropower project set up a special Monitoring group, which is responsible for data collection, supervision, recording and verification. The director of the Monitoring group has been trained by the consulting organization and can ask for technical support when required from the consultation organizations.

The responsibilities of each person involved are elaborated as follows:

Table 1: Group members and their responsibilities

Function	Name	Job Title	Responsibility
Representative	Nguyen Hai Quynh	Director of Song Ong Hydropower JSC	Legal representative of Song Ong Hydropower JSC

CDM group Manager	Nguyen Thanh Hai	Manager of Song Ong Power plant	Managing the whole monitoring business of Song Ong HPP, guiding and supervising data recorder after trained by Monitoring consultation.
Internal Auditor	Nguyen Le Duy	Deputy Manager of Song Ong Power plant	Check the monitoring procedure.
Meter supervisor	Nguyen Van Phe	Responsible for technology	Checking power meter periodically according to relevant regulation.
Monitoring consultant	Nguyen Tien Hai	Energy and Environment Consultancy JSC	Providing monitoring group director training and technical support about monitoring plan.
Meter supervisor	Tran Doan Thong	Shift leader	Checking power meter periodically according to relevant regulation.
Meter supervisor	Tran Dai Phu	Shift leader	Checking power meter periodically according to relevant regulation.
Data checker	Doan Quoc Viet	Shift leader	Double-checking the collected data measured by power meter.
Data checker	Vo Huy Cuong	Shift leader	Double-checking the collected data measured by power meter.
Data checker	Nguyen Le Huu Khanh	Crew leader	Monitoring the collecting and recording data every month
Data checker	Bui Van Thuong	Crew leader	Monitoring the collecting and recording data every month
Data checker	Vo Minh Tram	Crew leader	Monitoring the collecting and recording data every month
Data checker	Phan Quoc Vu	Crew leader	Monitoring the collecting and recording data every month
Data recorder	Bui Minh Huy	Staff member	Collecting and recording data every month.
Data recorder	Nguyen Quoc Anh	Staff member	Collecting and recording data every month.
Data recorder	Doan Minh Hieu	Staff member	Collecting and recording data every month.
Data recorder	Tu Van Tam	Staff member	Collecting and recording data every month.
Data recorder	Phan Thien Cuong	Staff member	Collecting and recording data every month.
Data recorder	Nguyen Minh Hung	Staff member	Collecting and recording data every month.

Data recorder	Nguyen Minh Chien	Staff member	Collecting and recording data every month.
Data recorder	Thai Xuan The	Staff member	Collecting and recording data every month.
Data recorder	Tran Quoc Nguyen	Staff member	Collecting and recording data every month.
Data recorder	Pham Van Truong	Staff member	Collecting and recording data every month.
Data recorder	Vo Ta Sy	Staff member	Collecting and recording data every month.
Data recorder	Hoang Minh Hoan	Staff member	Collecting and recording data every month.

The new staffs are not allowed to operate and maintain the equipment until they pass the exams and have acquired skills after the training.

All staff working for Monitoring group is already trained and the training record is archived. Through the training, staff has the necessary knowledge on the installation, examination and maintenance of electricity and machine; be familiar with the equipment operation principle and basic structure; master the cause and solution of common problems and the basic knowledge on monitoring requirement.

3.3.3 Data collection and management

Data collection

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:

- The electricity supplied by the project to the grid is automatically monitored by the meter systems (main and backup). The data is measured continuously.
- Data recorder, meter supervisor from Song Ong hydropower plant together with staff from EVN reads and collects data from main power meter on the first day of every month, the result is signed in a protocol by both parties and kept respectively;
- Project Owner provides electricity sales invoice to EVN for electricity exported to the grid, and keeps the copy of each invoice;
- EVN provides electricity sales invoices to Project Owner for electricity imported from the grid to the project. The copy of each invoice is also kept by the Project Owner (if any);
- Project Owner provides the record of main, backup power meter and copy of invoices to DOE for verification.

Data management

- The Monitoring group appointed by Song Ong Hydropower Plant keeps monitoring data in electronic format at the end of every month. Paper documents are stored in electronic format and copied on to a CD.

- Song Ong Hydropower plant keeps the copy of electricity sales/purchase invoice (the original electricity sales/purchase invoice is archived by Project Owner).
- In order to help verifiers obtain documents and information related to the emission reduction of the proposed project, Project Owner has prepared an index of the project documents and monitoring report.
- All the data and information in the form of paper documents are in archives by Monitoring group, with at least one copy backup for each datum.
- Hard copy of documentation is stored in cabinet for safety. Every month, Monitoring group leader and internal auditor check it to ensure that all data is good status.
- Data in electronic spreadsheet is stored on main hard disk and other type such as CD-ROM, memory stick. In addition, the Song Ong power plant sends a copy to VNEEC for secondary back up.
- All of the data will be kept for 2 years after the crediting period.

Emergency procedure for monitoring system

The main and backup power meters are used in order to record the electricity generated to the grid. These power meters are calibrated once in every two years. Monthly, the representatives of EVN and the Project Owner check the results in both main and backup power meters.

When there is any doubt about the inaccuracy of meters, the amount of the electricity supplied to the grid should be confirmed by Project Owner and EVN in the following steps:

- Conduct the calibration on power meters by accredited third party to ascertain which meter is erroneous.
- Under normal circumstance, the amount of electricity delivered to the grid measured by the main power meter will be adopted, but in case of trouble with the main power meter, the amount of electricity will be adjusted as follow:
  - Use the value recorded by the backup power meter.
  - If the backup power meters are also erroneous:
    - If the main power meter could record the electricity, the amount of electricity generated will be based on the value recorded by the main power meter after reaching a mutual agreement by both Project Owner and EVN.
    - If the main power meter could not record the electricity, the Project Owner and the EVN will jointly calculate a conservative estimation of the power supplied to the grid. The assumptions used to estimate the net electricity supplied to the grid will be signed by both representatives of the Project Owner and the EVN.
    - If the other cases happen and Project Owner and EVN cannot reach a mutual agreement on the conservative method to estimate the value of the power supplied to the grid during the trouble period, the arbitration shall be conducted according to Power Purchase Agreement.

Monitoring equipment of electricity

Song Ong hydropower plant has been started operating since 24 March 2009. The electricity generated from the project activity before entering into the grid at the grid connection point has been measured by a digital kilowatt hour (kWh) meter. The power meters were installed at the connecting point in 110/22kV Ninh Son transformer station. The metering system includes the main system and a back-up system, which are 3-phase meter.

The monitoring diagram of Song Ong hydropower project is as follow:

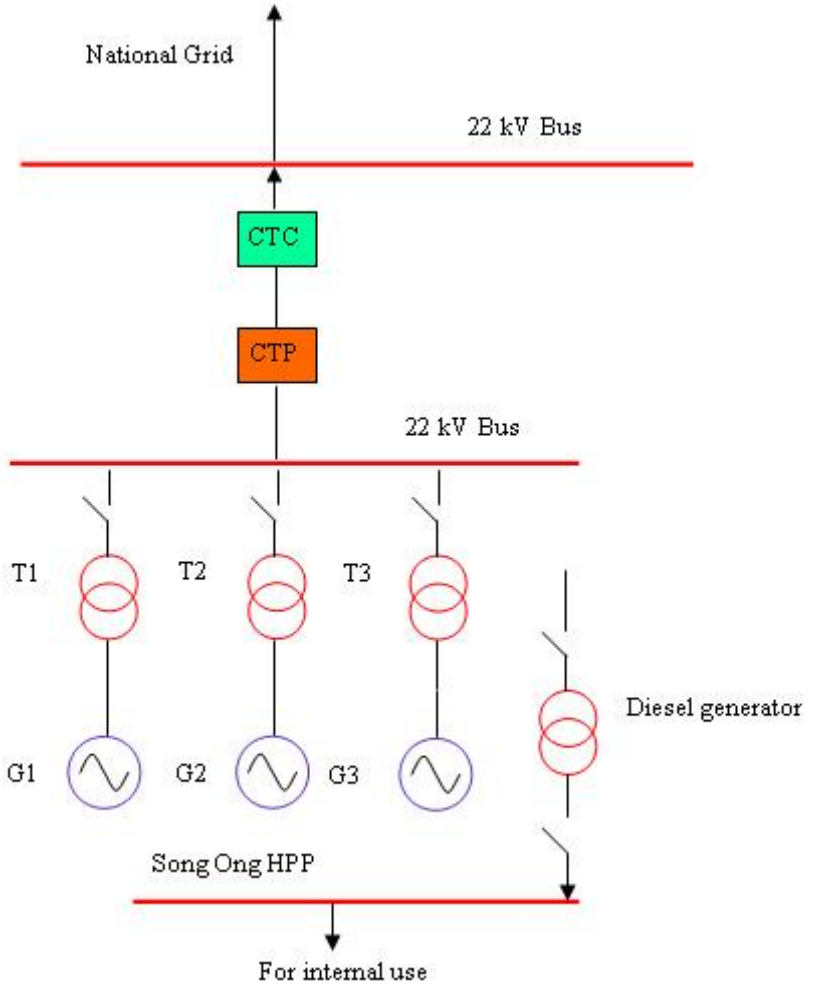

Figure 5: Metering System of Song Ong Hydropower plant

Notes:

CTC	The main power meter
CTP	The backup power meter
T1, T2, T3	The transformer 1, 2, 3, respectively
G1, G2, G3	The generator 1, 2, 3, respectively

The general information of power meters are shown in the table below:

Table 2: General information of power meters of Song Ong Hydropower project

Power meter	**The main power meter (CTC)**	**The back- up power meter (CTP)**

Manufacturer	Elster	Elster
Type	PB3KAAGHT-5	PB3KAAGHT-5
Serial number	08062733	08062734
Position	22kV Bus of 110/22kV Ninh Son Transformer station	22kV Bus of 110/22kV Ninh Son Transformer station
Function	Continuous measuring the amount of electricity exported to the national grid and consumed by Song Ong hydropower plant	Continuous measuring the amount of electricity exported to the national grid and consumed by Song Ong hydropower plant
Record frequency	The end of every month	The end of every month
Calibration party and frequency	By a third party, every 2 years	By a third party, every 2 years

All the power meters of Song Ong project are controlled by the EVN. The Project Owner signs an agreement with EVN that stipulates the quality control process of measurement and calibration in order to ensure the measurement precision. Periodical power meter inspection and on-site check should be implemented according to standards and regulations of the state electric power industry. After inspection and on-site check by both representatives of Project Owner and EVN, the power meters must be sealed in the witness of both parties. No party can remove the seal or modify the power meter when the other party (or its authorized representative) is not available.

The detail information of each power meter is in below tables:

Table 3: Technical details of the power meters

Power meter	**The main power meter**	**The back-up power meter.**
Serial No.	**08062733**	**08062734**
Inspection Report No.	244/BB/TND-DK	243/BB/TND-DK
Manufacturer	United Kingdom	
Model	Elster A1700	
Type	PB3KAAGHT-5	
Voltage	110/63.5kV	
Accuracy	0.5s (Wh) ; 2.0(Varh)	
Position	22kV Bus of 110/22kV Ninh Son Transformer station	
Function	Amount of electricity exported to and imported from the national grid by Song Ong Hydropower Plant	
Calibration date before installation	15 December 2008	
Installation date	05 March 2009	
Operating period	From 24 March 2009	
Calibration entity	Electrical testing center - Power Company No.2	

Calibration frequency	Every 2 years

Monitoring equipment of fuel consumption (FCi,j,y)

Song Ong hydropower project installed a diesel backup generator with the capacity of 250 KVA for emergency situation, such as both cut-off electricity supply and the hydropower station. The fuel used for operate the diesel generator is supplied from the storage tank of diesel generator. The volume of combusted fuel is determined by multiply the height of consumed fuel and the area of the tank bottom together. The technical parameter of the ruler is shown in the table follows.

Table 4: The technical parameter of the ruler

Type		Depth caliper
Manufacturer		China
Serial No.		0811100157
Technical Specification (mm)	Range:	0 - 300
	Scale:	0.02
Function		Measure the level of diesel in the tank

The dimensions of the tank were calibrated by a third party. The calibration result is shown in the table follows.

Table 5: The calibration detail of the tank

Date of verification		19 December 2008
Calibration certificated No.		21/03 BRB/2008
Verification entity		Branch of Standards Metrology and Quality of Ninh Thuan
Capacity (litre)		560
Dimension (mm)	Height	246
	Width	2,223
	Length	1,024

Thus, the area of the storage tank bottom is S = 2,223 x 1,024 = 2276,352 mm^2

The volume of combusted fuel is recorded in the log-book. It also is cross-checked with available purchase invoices from the financial records.

3.3.4 Quality Assurance and Quality Control

a) Internal Audit

This is an internal review to confirm that the scheduled or requested monitoring procedures at Song Ong Hydropower Project are followed in a proper way in confirmation to the CDM principles.

Regular Audit

The Monitoring group Director shall be responsible to ensure that internal audits are conducted at least once a year to ensure observance of the standards set forth.

According to the internal audit reports, deputy manager of Song Ong Hydropower plant has carried out internal audit once per month, and the result of each month reflect that the quality of operation and monitoring of staffs is improving and they follow the operation guidance of hydropower plant and monitoring manual.

Occasional Audit

Occasional audit is conducted by the request from the Director. In the crediting period, the occasional audits were conducted about every three months.

Management review

Management review of the project is made once a year in order to review the monitoring and internal audit process and results.

In the crediting period, the measuring equipment operated stably. The operation staff followed the CDM monitoring procedure.

b) Calibration and Maintenance

The Project Owner had signed an agreement with EVN that stipulates the quality control process of measurement and calibration in order to ensure the measurement precision. Periodical power meter inspection and on-site check should be implemented according to standards and regulations of the state electric power industry. After inspection and on-site check by both representatives of Project Owner and EVN, the power meters must be sealed. The Project owners and EVN inspect and seal together, no party can remove the seal or modify the power meter when the other party (or its authorized representative) is not available.

The details history of power meters of Song Ong hydropower project:

The power meter system with the accuracy level of 0.5s was installed on 05 March 2009 and started operating on 24 March 2009. The power meters have been calibrated by Electrical Testing Centre of Power Company No.2 (a division of EVN which is accredited as an entity for calibration all electrical measurement equipment). During the operating period, the power meters system has been in good state with no reported problems.

Table 6: The history calibration result of the power meters

Technical details	**Main System (CTC)**	**Back-up System (CTP)**
Serial No.	**08062733**	**08062734**
The first calibration	13 January 2010	13 January2010
Result of testing	Pass	Pass
Calibration entity	Electrical testing center - Power Company No.2	Electrical testing center - Power Company No.2
Calibration frequency	Once every 2 years	Once every 2 years
Expected date for the next calibration	13January 2012	13 January 2012

The ruler is calibrated annually and the detail of each calibration is shown in the table below.

Table 7: The history calibration result of the ruler gauge

Type		Depth caliper
Manufacturer		China
Serial No.		0811100157
Technical Specification	Range	0 - 300 mm
	Scale	0.02 mm
The 1st calibration	Calibration Certificate No.	V01.CN5.3029.08
	Date	29 December 2008
	Result	Uncertainty of measurement: U = (5+8L) µm, where [L]: m
The 2nd calibration	Calibration Certificate No.	V01.CN5.3250.09
	Date	23 December 2009
	Result	Uncertainty of measurement: U = (5+8L) µm where [L]: m
The 3rd calibration	Calibration Certificate No.	V01.CN5.33358.10
	Date	17-12-2010
	Result	Uncertainty of measurement: U = (5+8L) µm where [L]: m
Expected next calibration date		17-12-2011

c) CDM training course:

In February 2009, VNEEC cooperated with Song Ong Hydropower JSC., to organize a training course, which was intended to improve the skill of all Song Ong hydropower plant's staff about every necessary information and procedures related to CDM monitoring. The main monitoring training contents include: monitoring organization, file system, connection point, monitoring parameters, monitoring method, guideline against dispute resolutions, data management, calibration and maintenance, monitoring reports, internal audit, and management review.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions include only CO_2 emissions from electricity generation by fossil fuel fired power plants that are displaced due to the project activity. It is calculated by the formula below:

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

Where:

BE_y Baseline emission (tCO_2e)

$EG_{BL,y}$ Net electricity supplied by the Hydropower plant to the grid in year y (MWh)

$EF_{CO2,grid,y}$ Emission factor of the grid (tCO_2/MWh)

$EF_{CO2,grid,y}$ = 0.5355 tCO_2/MWh is ex-ante and fixed during the crediting period

The monitoring results for the monitoring period are as follows:

Table 8: Baseline emission calculation in 2009

Period		Electricity exported (MWh)	Electricity imported (MWh)	Net electricity (MWh)	Baseline Emission (tCO_{2e})
From	To				
24/03/2009	31/03/2009	504.1	0.1	504.0	269.89
01/04/2009	30/04/2009	2,928.1	0.1	2,928.0	1,567.94
01/05/2009	31/05/2009	3,105.9	0.1	3,105.8	1,663.15
01/06/2009	30/06/2009	3,221.3	0	3,221.3	1,725
01/07/2009	31/072009	3,183.8	0.1	3,183.7	1,704.87
01/082009	31/08/2009	383.5	0	383.5	205.36
01/09/2009	30/09/2009	2,314.6	0.1	2,314.6	1,239.46
01/10/2009	31/10/2009	3,654.4	0	3,654.4	1,956.93
01/11/2009	30/11/2009	3,672.1	0	3,672.1	1,966.4
01/12/2009	31/12/2009	3,418.6	0	3,418.6	1,830.66
Total		**26386.4**	**1.0**	**26385.4**	**14129.38**

Table 9: Baseline emission calculation in 2010

Period		Electricity exported (MWh)	Electricity imported (MWh)	Net electricity (MWh)	Baseline Emission (tCO_{2e})
From	To				
0/01/2010	31/01/2010	3,011.6	0.3	3,011.3	1,612.55
01/02/2010	28/02/2010	1,915.8	0.2	1,915.6	1,025.8
01/03/2010	31/03/2010	2,630.5	0	2,630.5	1,408.63
01/04/2010	30/04/2010	3,169.5	0	3,169.5	1,697.26
01/05/2010	31/05/2010	3,010.6	0	3,010.6	1,612.17
01/06/2010	30/06/2010	3,722.8	0	3,722.8	1,993.55
01/07/2010	31/07/2010	4,393.5	0	4,393.5	2,352.71
01/08/2010	31/08/2010	4,387.0	0	4,387.0	2,349.23
01/09/2010	30/09/2010	3,682.8	0	3,682.8	1,972.13
01/10/2010	31/10/2010	5,304.1	0	5,304.1	2,840.34

01/11/2010	30/11/2010	5,047.5	0	5,047.5	2,702.93
01/12/2010	31/12/2010	4,563.1	0.3	4,562.8	2,443.37
01/01/2011	31/01/2011	3,413.4	0	3,413.4	1,827.87
01/02/2011	28/02/2011	2,403.9	0	2,403.9	1,287.28
Total		**44838.8**	**0.3**	**44838.5**	**24011.01**

Table 10: Baseline emission calculation in 2011

Period		**Electricity exported (MWh)**	**Electricity imported (MWh)**	**Net electricity (MWh)**	**Baseline Emission (tCO_{2e})**
From	To				
01/01/2011	31/01/2011	3,413.4	0	3,413.4	1,827.87
01/02/2011	28/02/2011	2,403.9	0	2,403.9	1,287.28
Total		**5817.30**	**0**	**5817.30**	**3115.16**

In summary:

Table 11: Baseline emission calculation for Song Ong Hydropower project

Period		Electricity exported (MWh)	Electricity imported (MWh)	Net electricity (MWh)	Baseline Emission (tCO_{2e})
From	To				
24/03/2009	31/12/2009	26836.4	1.0	26385.4	14129.38
01/01/2010	31/12/2010	44838.8	0.3	44838.5	24011.01
01/01/2011	28-02-2011	5817.3	0	5817.3	3115.16
Total		**77,042.5**	**1.3**	**77,041.2**	**41,255 (rounded down)**

The total Baseline emission BE_y for the monitoring period is BE_y = 41,255 tCO_2e

4.2 Project Emissions

Song Ong Hydropower project emission includes the two proponents of emission from the backup power and a new reservoir. The following formula is applied:

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

PE_y The project emissions

$PE_{FF,y}$ The backup power emissions

$PE_{HP,y}$ The emissions from the reservoir

Emissions from the reservoir ($PE_{HP,y}$)

The project activity involves the construction of a new hydropower plant with installed capacity (Cap_{PJ}) of 8.1 MW and a new reservoir with surface (A_{PJ}) of 1.7 ha, thus A_{BL} = 0 and Cap_{BL} = 0.

The project owner has conducted the annual measurement of reservoir size. The measurement has been implemented by a third party verifier. The power density of the project activity is derived as the equation 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.

Therefore, the power density of the project activity in the monitoring period is calculated as below:

In 2009:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} = \frac{8.1\times10^6 - 0}{1.7464\times10^4 - 0} = 463.8(W/m^2)$$

In 2010:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} = \frac{8.1\times10^6 - 0}{1.7448\times10^4 - 0} = 464.2(W/m^2)$$

Because the power density (*PD*) of power plant in 2009 and 2010 are both greater than 10 W/m^2 so:

$$PE_{HP,y} = 0\ (tCO_{2e}/year)$$

Emission from the diesel backup generator ($PE_{FF,y}$)

The diesel backup generators are used for generating electricity for internal use in the plant when the generation from the plant is temporarily terminated. However, this case rarely happens and is not at any frequency.

According to the "Tool to calculate project or leakage CO_2 emissions from fossil fuel consumption", the annual CO_2 emissions from diesel oil combustion are calculated as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

$$\text{and } COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:

$PE_{FC,j,y}$ The CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2e/yr)

$FC_{i,j\,y}$ The quantity of fuel type *I* combusted in process *j* during the year *y* (mass or volume unit/yr)

$COEF_{i,y}$ The CO_2 emission coefficient of fuel type *I* in year *y* (tCO_2/mass or volume unit)

$NCV_{i,y}$ The weighted average net calorific value of the fuel type *I* in year *y*

$EF_{CO2,i,y}$ The weighted average CO_2 emission factor of fuel type *I* in year *y* (tCO_2/GJ)

I The fuel types combusted in process *j* during the year *y*

According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the NCV of diesel oil is 43.3 TJ/Gg and the emission factor is 74,800 kgCO2/TJ, and thus the $COEF_{i,y}$ = 0.0032 tCO_2/kg diesel.

Therefore, $PE_{FC,j,y} = FC_{i,j\,y} * 0.0032$

The fuel consumed for the power backup in the monitoring period is 333.87 liters So $FC_{i,j}$ = 333.87/1185 = 0.282 tones[3].

The emission from the backup generator is calculated as:

$PE_{FF} = 0.282 * 0.0032 * 1000 = 0.902$ (tCO_2e)

The emission from the backup generator with the value of 0.902 tCO_2e is much smaller than the value of 412.55 tCO_2e which equal to 1% of baseline emission in the monitoring period. So the emission from this source is considered very negligible or $PE_{FF,y}$ = 0.

Therefore the GHG emission from the project activity is considered as zero.

$$\mathbf{PE_y = PE_{FF,y} + PE_{HP,y} = 0}$$

4.3 Leakage

The technology used in this project is neither transferred to nor transferred from another activity leakage is considered to be zero (L_y = 0)

4.4 Summary of GHG Emission Reductions and Removals

According to the calculation above, the project emission and leakage from the project activity are zero, emission reduction during the monitoring period is:
$ER_Y = BE_Y – PE_Y – L_Y = BE_Y$ = 41,255 tCO_2 (rounded down)
The estimated and actual emission reductions of Song Ong hydropower project are summarized in the table below:

Table 12: Emission reduction calculation for Song Ong Hydropower project

Period		**Emission reduction** (tCO_{2e})	
From	To	Ex-ante calculation in the registered CDM-PDD	Actual
24/03/2009	31/12/2009	16,605	14,129
Remarks: In the period from 24 March 2009 to 31 December 2009 (equal to 283 days), the actual ER is smaller than the ex-ante estimated ER due to the emergency occurred in August 2009. The power plant had not operated for over one month, and in the next 4 months, only the unit no. 01 and 02 were operated.			

[3] 1185 is default value of litres per tone diesel oil according to Energy Statistic Manual published in 2004 by the International Energy Agency, Organization for Economic Co-operation and Development and Eurostat.

01/01/2010	31/12/2010	21,416	24,011
Remarks: In the period 01 January 2010 till 31 December 2010 (equal to 365 days), the actual ER is larger than ex-ante one due to the hydropower plant was operated stably and the flow rate was high enough for the plant to operate at full capacity.			
01/01/2011	28/02/2011	3,461	3,115
Remarks: In the period of 01 January 2012 to 28 February 2011 (equal to 59 days), the actual ER is smaller than ex-ante due to the monitored period in 2011 is in dry season. On the other hand, the value applied in ex-ante calculation is based on the estimated emission reduction for a year (involves four months of rainy season and eight months of dry season)			
Total		**41,484** (rounded)	**41,255** (rounded)

5 ADDITIONAL INFORMATION

Not applicable

ANNEX 1

BASELINE INFORMATION

Data of power plants in Vietnam national grid in 2005, 2006 and 2007[4]

Table 12: Data for calculation of $EF_{grid, OM}$

Sr. No.	Power Station	Fuel/ Technology	Heat Rate Kcal/KWh	Annual Generation GWh			Efficiency %	$EF_{CO2,m,i,y}$ (tCO_2/GJ)	$EF_{EL,m,y}$	$EG_{m,y}*EF_{EL,m,y}$ (tCO2)		
	EVN Plants			**2005**	**2006**	**2007**				**2005**	**2006**	**2007**
1	**Pha Lai 1**	Coal/ST	3,037.00	2,462.40	2,766.70	2,830.00	28.31%	0.0946	1.20286848	2,961.94	3,327.98	3,404.12
2	**Pha Lai 2**	Coal/ST	2,402.00	4,299.00	4,315.00	4,198.00	35.80%	0.0946	0.95136321	4,089.91	4,105.13	3,993.82
3	**Uong Bi**	Coal/ST	3,877.00	668.90	759.10	693.90	22.18%	0.0946	1.53556835	1,027.14	1,165.65	1,065.53
4	**Uong Bi 2**	Coal/ST	1,880.00			520.00	45.74%	0.0946	0.74461401	-	-	387.20
5	**Ninh Binh**	Coal/ST	3,824.00	689.53	794.70	728.90	22.49%	0.0946	1.51457657	1,044.35	1,203.63	1,103.97
6	**Thu Duc**											
	ST	FO/ST	2,694.00	549.99	471.94	603.30	31.92%	0.0755	0.85158256	468.36	401.90	513.76
	GT	DO/GT	3,431.00	34.35	32.29	70.26	25.06%	0.0726	1.04289252	35.82	33.67	73.27
7	**Can Tho**											
	ST (S4)	FO/ST	2,709.00	127.76	127.87	137.30	31.74%	0.0755	0.85632411	109.40	109.50	117.57
	(GT1,2,3,4)	DO/GT	3,056.00	141.63	108.74	150.70	28.14%	0.0726	0.92890689	131.56	101.01	139.99
8	**Ba Ria**											
	CCGT	Gas/CCGT	2,210.00	2,150.50	2,024.30	1,982.70	38.91%	0.0543	0.50242856	1,080.47	1,017.07	996.17

[4] Source: EVN, 2009

9	**Phu My 1**											
	CCGT	Gas/CCGT	1,746.00	7,179.14	6,421.71	8,076.73	49.25%	0.0543	0.3969413	2,849.70	2,549.04	3,205.99
10	**Phu My 2.1**											
	CCGT	Gas/CCGT	1,857.00	3,640.97	6,110.50	5,975.20	46.30%	0.0543	0.4221764	1,537.13	2,579.71	2,522.59
11	**Phu My 4**											
	CCGT	Gas/CCGT	1,829.00	3,125.93	3,209.00	3,276.80	47.01%	0.0543	0.41581079	1,299.80	1,334.34	1,362.53
	IPPs											
1	Na Duong	Coal	2,748.00	389.00	709.00	744.00	31.29%	0.0946	1.08840388	423.39	771.68	809.77
2	Hiep Phuoc	DO	3,232.00	1,424.00	955.00	1,726.00	26.60%	0.0726	0.98240415	1,398.94	938.20	1,695.63
3	Formosa	Coal	2,270.00	800.00	1,086.00	1,113.00	37.88%	0.0946	0.89908181	719.27	976.40	1,000.68
4	Amatar	DO	3,300.00	67.00	26.00	13.00	26.06%	0.0726	1.00307354	67.21	26.08	13.04
5	Bourbon	Co-gen	2,700.00	43.00	57.00	69.00	31.85%	0	0	-	-	-
6	Ve Dan	Gas	2,900.00	463.00	514.00	534.00	29.65%	0.0543	0.6592954	305.25	338.88	352.06
7	Cai Lan	DO	3,300.00			81.00	26.06%	0.0726	1.00307354	-	-	81.25
8	Phu My 2.2	Gas	1,573.00	3,719.00	4,855.00	5,004.00	54.66%	0.0543	0.35761092	1,329.95	1,736.20	1,789.49
9	Phu My 3	CCGT	1,739.00	4,442.00	4,110.00	3,883.00	49.44%	0.0543	0.39534989	1,756.14	1,624.89	1,535.14
10	Cao Ngan	Coal	2,748.00		70.00	445.00	31.29%	0.0946	1.08840388	-	76.19	484.34
11	Ca Mau	Gas	2,583.20			691.00	33.29%	0.0543	0.58727306	-	-	405.81
Sum				**36,417.10**	**39,523.85**	**43,546.79**				**22,635.75**	**24,417.14**	**27,053.72**

Table 13: Data for calculation of $EF_{grid, BM, 2007}$

Sr. No.	Name of plant	Unit	Date of commissioning	Capacity	Technology	Generation GWh		$EF_{EL,m,y}$	$EG_{m,y}*EF_{EL,m,y}$
				[MW]		2007			
1	M1 Dai Ninh	M1	11-Dec-07	150	Hydro	0.04	0%	0	0
2	Quang Tri					64	0%	0	0
	M2 Quang Tri	M2	27-Nov-07	32	Hydro		0%	0	0
	MI Quang Tri	M1	12-Sep-07	32	Hydro		0%	0	0
3	Se San 3A					345	1%	0	0
	M2 Se San 3A	M2	22-May-07	54	Hydro		1%	0	0
	M1 Se San 3A	M1	12-Dec-06	54	Hydro		1%	0	0
4	Ca Mau					691	2%	0.587273	405.8056828
	GT2 Ca Mau	GT2	24-Apr-07	250	Thermal		2%	0	0
	GT3 Ca Mau	GT3	04-Apr-07	250	Thermal		2%	0	0
5	Cai Lan		08-Mar-07	6x6.5	Thermal	81	2%	1.003074	81.24895706
6	Srok phu mieng					252	2%	0	0
	Srok phu mieng	M2	03-Jan-07	26	Hydro		2%	0	0
	Srok phu mieng	M1	12-Oct-06	25	Hydro		2%	0	0
7	Uong Bi 2	M7	18-Dec-06	300	Thermal	520	3%	0.744614	387.1992833
8	Se San 3					1130	4%	0	0
	M2 Se San 3	M2	28-Jul-06	130	Hydro		4%	0	0
	MI Se San 3	M1	23-Apr-06	130	Hydro		4%	0	0
9	Cao Ngan					445	5%	1.088404	484.3397255
	M1 Cao Ngan	M1	03-Feb-06	57.5	Thermal		5%	0	0
	M2 Cao Ngan	M2	10-May-06	57.5	Thermal		5%	0	0
10	Na Duong					744	6%	1.088404	809.7724848
	Na Duong S2	S2	28-Otc-05	50	Thermal		6%	0	0
	Na Duong S1	S1	25-Apr-04	50	Thermal		6%	0	0
11	Phu My 2.2					5004	14%	0.357611	1789.485026
	GT1 Phu My 2.2	GT1	03-Oct-04	250	Thermal		14%	0	0
	GT2 Phu My 2.2	GT2	04-Sep-04	250	Thermal		14%	0	0

	ST3 Phu My 2.2	**ST3**	**05-Sep-04**	**263**	**Steam Turbine**		14%	0	0
12	**Phu My 4**					**3210**	18%	0.415811	1334.752623
	GT42 Phu My 4	**GT42**	**03-Sep-04**	**237**	**Thermal**		18%	0	0
	ST43 Phu My 4	**GT41**	**03-Apr-04**	**178**	**Thermal**		18%	0	0
	ST43 Phu My 4	**ST43**	**14-May-04**	**150**	**Steam Turbine**		18%	0	0
13	**S1 Formosa**	**S1**	**31-Mar-04**	**150**	**Thermal**	**1113**	19.8%	0.899082	1000.67805
14	**Can Don**					**361**	20.3%		0
	M2 Can Don	**M2**	**02-Feb-04**	**38.8**	**Hydro**		20.3%		
	MI Can Don	**M1**	**21-Nov-03**	**38.8**	**Hydro**		20.3%		
15	**Na Loi**		**03-Dec-03**	**3x3.1**	**Hydro**	**47**	20.4%		
16	**Phu My 3**					**3882**	26%		
	GT1 Phu My 3	**GT1**	**03-Aug-03**	**237**	**Thermal**	**1247**	28%		
	GT2 Phu My 3	**GT2**	**03-Aug-03**	**237**	**Thermal**	**1247**	30%		
	ST3 Phu My 3		**03-Aug-03**	**263.7**	**Thermal**	**1388**	32%		
17	**M6 Pha lai 2**		**30-May-02**	**300**	**Thermal**	**4198**	38%		

Table 14: IPCC default value

Fuel fossil	CO2 emission factor [kg CO2/TJ]	Source
Diesel	72,600	*IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories*
Residual Fuel Oil	75,500	
Anthracite	94,600	
Gas	54,300	
Biomass	0	