**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 6 Hydropower Project
Version: 2.3
Date: 03/10/2011

### A.2. Description of the project activity:

The Song Bung 6 Hydropower Project involves the construction and operation of a hydropower plant which is located on Bung River, Ma Cooih commune and Ka Dang commune in Dong Giang district and Thanh My town in Nam Giang district, Quang Nam province of 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 and to supply renewable electricity to the national grid via the Power Purchase Agreement (PPA) will be signed with the Electricity Corporation of Viet Nam (EVN). The project's installed capacity and annual gross power generation are respectively 29 MW and 120.52 GWh[1]. The net electricity generated from this project (annual estimated volume is 118.712 GWh[2]) will be supplied to the national grid via 110kV transmission line (length of around 13 km) which connects the plant with the 220/110kV Thanh My 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 mainly fossil fuel fired power plants. The project involves construction of a reservoir with an area of 39.80 ha[3], and a power density of 72.9 $W/m^2$, accordingly. As the power density of this project is above 10 $W/m^2$, no GHG emissions from the reservoir need to be accounted in the project activity as per the methodology applied, ACM0002, Version 12.2.0. Thus, this project activity generates GHG emission reductions up to a total expected $CO_2$ emission reduction of 478,975 $tCO_2$ 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 from 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.
- 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.

[1] Feasibility Study Report
[2] The gross power generation subtracts 1.5% for parasitic and loss load
[3] EIA report page 8

**Contributions towards local sustainable development:**

a) Economic well-being

Once commissioning, this proposed project will increase the industrial share in the economic construction of Quang Nam province. This proposed project will pay annual enterprise's revenue tax, the natural resource tax[4] and CERs tax[5] to the state budget.

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 communes.

b) Social well-being

Dong Giang and Nam Giang are the poorest mountainous districts of Quang Nam province where the quality infrastructure system is very low and the living conditions of local people are not good. The project will construct new roads and upgrade existing ones that then will be integrated into the traffic system of the communes. Thus, by improving the infrastructures, the project will bring more opportunities for facilitating trading activities in the area that in its turn leads to improve minorities' living standards and contribute to fill the gap in development between different ethnic groups in Viet Nam. The majority of local residents living in the project area are from the ethnic minorities like Co Tu, Gie-Trieng, they usually live in less favourable living conditions than those of Kinh ethnic – the majority of population in Viet Nam.

The project will construct a new 110 kV transmission line together with the hydropower plant, which will reduce electricity losses and improve the quality of electricity supply in the region.

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 and satisfies the sustainable development criteria for CDM projects set by the DNA 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) | Song Bung Joint Stock Company (Private entity) | No |
| Viet Nam (host) | Energy and Environment Consultancy Joint Stock Company (Private entity) | No |
| 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 | | |

[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.

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):**

Socialist Republic of Viet Nam

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

Quang Nam province

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

Ma Cooih and Ka Dang communes, Dong Giang district
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 Song Bung 6 Hydropower Project involves the construction and operation of a hydropower which is located on Bung River, Ma Cooih commune and Ka Dang commune in Dong Giang district and Thanh My town in Nam Giang district, Quang Nam province of Viet Nam.

The geographic co-ordinates of the dam[6] are:

Northern latitude: $15^0$48'46''

Eastern longitude: $107^0$45'28''

The site of the project is showed in Figure 1.

[6] The geographic coordinator of plant in FS report

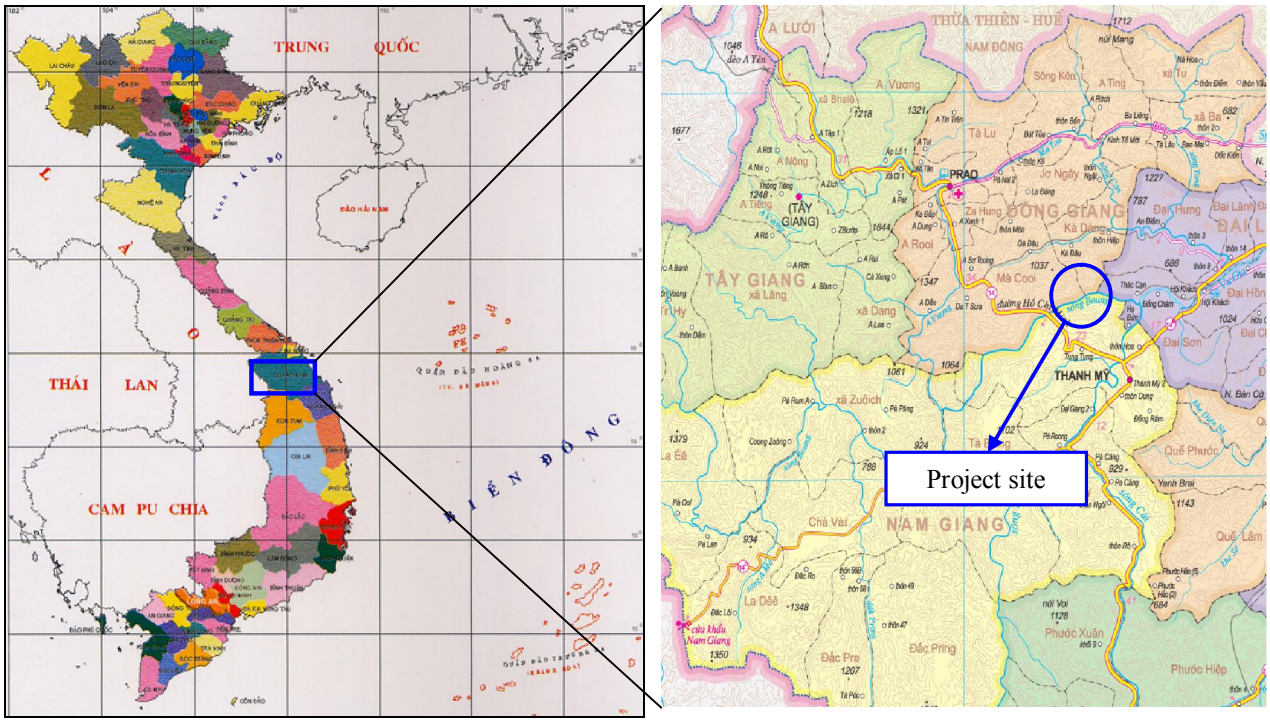


**Figure 1: Map of the location of the project activity**

## 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 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 via 110 kV transmission line. It also involves the construction of a reservoir with a power density of 72.9W/$m^2$, 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.

The metering system includes the main system and back-up systems, each system includes: current transformers (CTs), voltage transformers (VTs) and power meters which meet the IEC62053 or equivalent standard.

- Current Transformers (CTs) are used for measurement of electric currents. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a

reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments (power meters).

- Voltage Transformers (VTs) are used in power systems to step-down extra high voltage signals and provide low voltage signals either for measurement.
- Power meters are used to combine the current and voltage signal from CTs and VTs to measure the electrical power. More detail about the power meters are described in Annex 4.

Figure 2 shows the layout of the project.

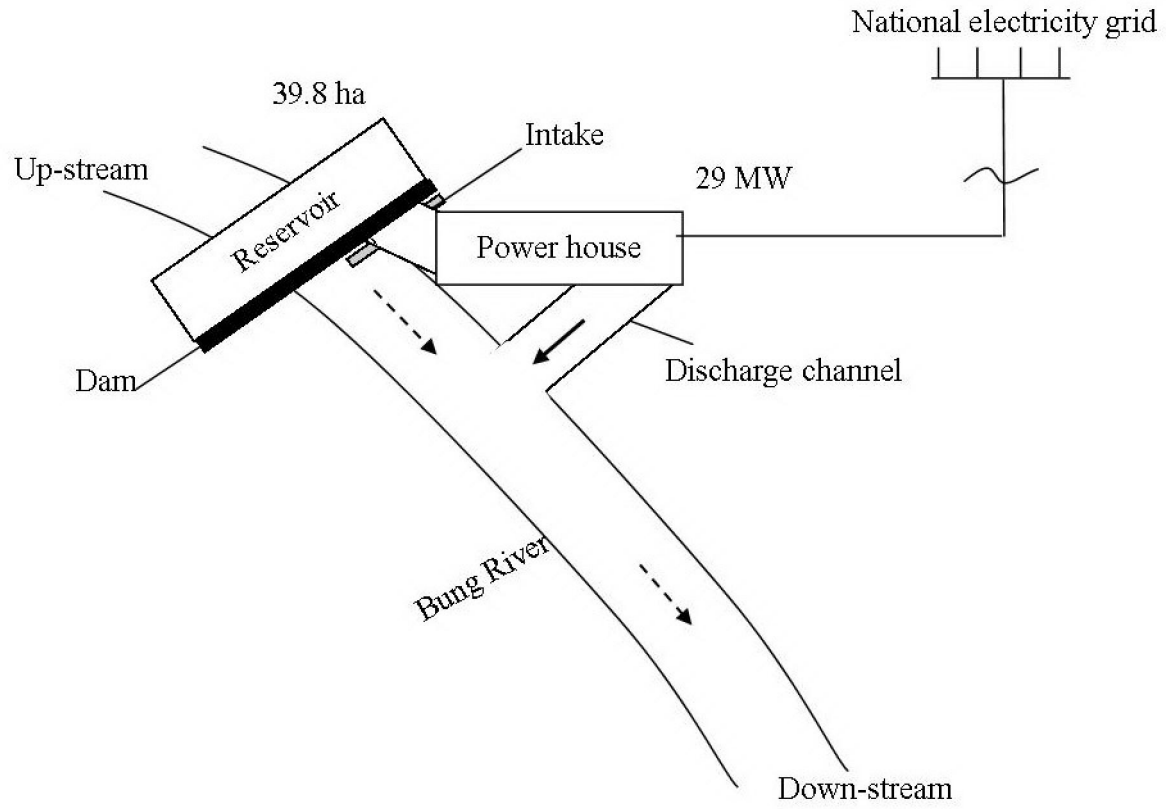


**Figure 2: Song Bung 6 hydropower plant's lay-out**

The project's installed capacity and annual gross power generation are respectively 29 MW and 120.52 GWh[7]. The net electricity generated from this project (annual estimated volume is 118,712 GWh[8]) will be supplied to the national grid via 110kV transmission line which connects the plant with the 220/110kV Thanh My Transformer station.

The main technical parameters of the Song Bung 6 Hydropower Project are shown in Table 1.

[7] FS Report with change capacity
[8] The gross power generation subtracts 1.5% for parasitic and loss load

**Table 1: Main technical parameters of the proposed project activity[9]**

| Main parameters | Units | Values |
|---|---|---|
| 1. Turbine | | |
| • Number | units | 02 |
| • Type | | Horizontal |
| • Capacity | MW | 15.091 |
| • Rate net head | m | 13.4 |
| • Efficiency | % | 94.6 |
| • Speed | rpm | 150 |
| • Annual utilization hours[10] | hour | 4156 |
| • Expected lifetime[11] | hour | 150,000 |
| 2. Generator | | |
| • Number | set | 02 |
| • Type | | Synchronous, 3 phases, horizontal axis |
| • Rated voltage | kV | 10.5 |
| • Rated capacity | MW | 14.5 |
| • Efficiency at 100% load, Cosφ = 0.95 | % | 97.0 |
| • Expected lifetime[12] | year | 30 |
| 3. Transformer | | |
| • Number | set | 01 |
| • Type | | 3 phases, 2 windings |
| • Primary voltage | kV | 10.5 |
| • Secondary voltage | kV | 115 |
| • Expected lifetime[13] | year | 30 |
| 4. Annual river flow | $m^3/s$ | 121.60 |

The main equipments utilized in this project have been imported from China via the Contract No 68/HDTB01-SB-P1 dated on 17 November 2010. All the turbines and alternators will be state-of art technology and meet the criteria as mutually agreed i.e. ensuring environmental safe and sound 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:

[9] The signed equipment contract
[10] The FS report with change capacity
[11] The default lifetime in EB50, Annex 15
[12] The default lifetime in EB50, Annex 15
[13] The default lifetime in the EB 50, Annex 15. the lifetime of Transformer is about 30 years

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**

| Years | Annual estimation of emission reductions in tonnes of $CO_2$ e |
|---|---|
| 2013(01/01/2013 - 31/12/2013) | 68,425 |
| 2014 | 68,425 |
| 2015 | 68,425 |
| 2016 | 68,425 |
| 2017 | 68,425 |
| 2018 | 68,425 |
| 2019(01/01/2019 - 31/12/2019) | 68,425 |
| **Total estimated reductions** (tonnes of $CO_2$ e) | **478,975** |
| **Total number of crediting years** | **7** |
| **Annual average over the crediting period of estimated reductions** (tonnes of $CO_2$ e) | **68,425** |

### 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? |
|---|---|---|
| This methodology is applicable to grid-connected renewable power generation project activities that (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (green field plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s). | The project activity consists in the installation of a new grid connected renewable power plants at a site where no renewable power plant was operated prior to the implementation of the project activity (green field plant) | Yes |
| 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 is the installation of new hydropower plant. | Yes |
| In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 10 to calculate the parameter $EG_{PJ,y}$): the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity; | The project activity is the installation of new hydropower plant. | Not applicable |
| In case of hydro power plants:<br>• The project activity is implemented in an existing reservoir, with no change in the volume of reservoir<br>• The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density (installed power generation capacity divided by the surface area at full reservoir level) of the project activity, is greater than 4 $W/m^2$<br>• The project activity results in new reservoirs and the power density of the power plant is greater than 4 $W/m^2$ | The project activity constructs a new reservoir.<br><br>The project activity constructs a new reservoir.<br><br>The power density of the Song Bung 6 is 72.90 $W/m^2$. | Not applicable<br><br>Not applicable<br><br>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 | It is a renewable energy project with no fuel-switch involved. | Yes |

| | | |
|---|---|---|
| continued use of fossil fuels at the site; | | |
| This methodology is not applicable to the biomass fired power plants; | The project activity is a hydropower plant. | Yes |
| This methodology is not applicable to hydro power plants that result in new reservoirs or in the increase in existing reservoirs where the power density of the power plant is less than 4 W/m$^2$. | The power density of the Song Bung 6 is 72.90 W/m$^2$; it is above 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 6 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.

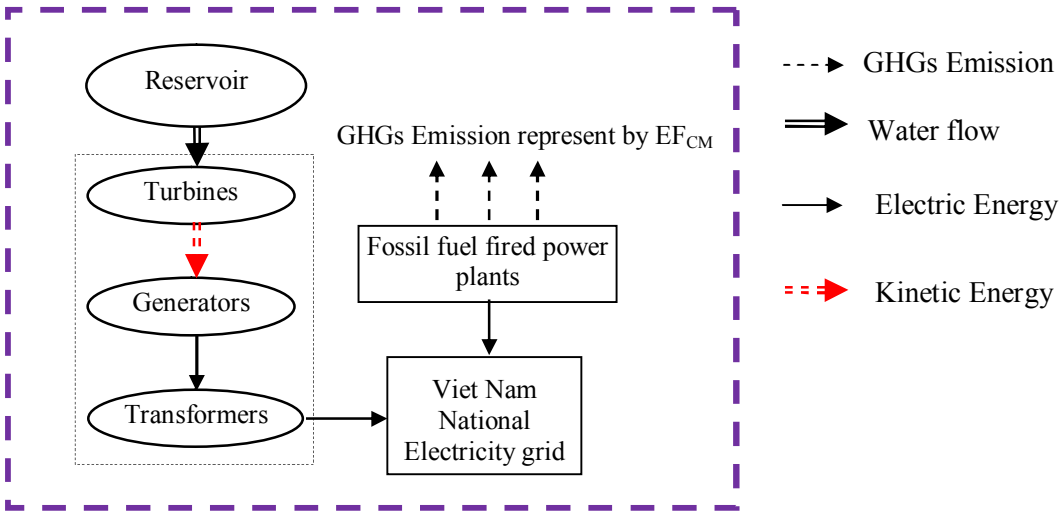


**Figure 3: Project boundary**

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 is 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. However, as the power density of the project is greater than 10 $W/m^2$ $CH_4$ emissions are neglected according to ACM0002. |
| | | $N_2O$ | 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 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 Viet Nam national grid to which the proposed project is also connected. The database for calculating the baseline is provided by the DNA of Viet Nam.

The analysis and description in B5 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 version 06.0.0 of the additionality tool 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."

We will therefore consider the two scenarios in the following analysis:

– Alternative 1 : the proposed project 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" alternative does not face with 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 6 Hydropower project is received the Investment License No.49/CN-UBND issued by People's Committee of Quang Nam province on 09/10/2009, which defines legal right of the project owner to invest in and construct Song Bung 6 Hydropower project. Therefore, the alternative 1 "the proposed project is undertaken without the CDM" is consistent with mandatory laws and regulations of Viet Nam.

**Step 2: Investment analysis**

***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.

The Song Bung 6 Hydropower project is received the Acceptance for connecting to the national grid No.3400/NP-KT issued by EVN on 28/12/2009, which accepts project owner to invest in and construct Song Bung 6 Hydropower project. Therefore, the the simple cost analysis (Option I) is not applicable.

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

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

As guided in para 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*", the project participant applies the local lending rates available at the time of making the investment decision as the benchmark.

Weekly, the State Bank of Viet Nam publishes a monetary report that provides the statistic data of the interest rates prevailing in the market during the reporting period. Such a report is published at the website of the State Bank weekly (www.sbv.gov.vn/en/). The benchmark of the proposed project is 13.60%. This benchmark is derived from the average long-term lending rates available from the beginning of 2010 up to the date of making the investment decision.

**The benchmark of 13.6% at the date of making the investment decision is a standard value.**

**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 below:

**Table 5: Key assumption for investment analysis**

| No | Parameter | Unit | Value | Source |
|---|---|---|---|---|
| 1 | Gross capacity | MW | 29 | "Official document No 1394/UBND-KTN issued by Quang Nam People's Committee dated on 26 April 2011 |
| 2 | Annual net electricity generation | MWh | 118,712 | The gross power generation subtracts 1.5% for parasitic and loss load |
| 3 | Total investment cost | billion VND | 634.4 | Investment license |
| 4 | Total annual O&M cost | billion VND | 6.344 | Decision No. 2014/QD-BCN issued by the Ministry of Industry |
| 5 | Construction period | year | 2.5 | "General Description" of Song Bung 6 hydropower project |
| 6 | Life time | year | 37 | Lifetime for financial analysis was based on the lifetime of equipment according to EB 50, Annex 15 |
| 7 | Electricity price | VND/kWh | 784.91 | According to Decision 73/QD-DTDL issued by Ministry of Industry and Trade on avoided cost tariff issued in 2009 (application in 2010) |
| 8 | Resources tax | % | 2 | The Circular No 124/2009/TT-BTC issued by Ministry of Finance on 17 June 2009<br>Decision No 588/QĐ-BTC issued by Ministry of Finance on 22 March 2010 regulates that the resource tax will be calculated as the net electricity outputs supplied to the national electricity grid x 1058 VND x 2% |
| **9** | **Pre-tax Project IRR** | **%** | **11.98** | |

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 24 June 2010.

***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. According to EB 62, Annex 13, paragraph 20:"Only variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenue should

be subjected to reasonable variation", the following parameters are used in the sensitivity analysis of the project activity:

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

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

**Table 6: Sensitivity analysis**

| No | Parameter | Variation[14] | Project IRR | Likelihoods to happen |
|---|---|---|---|---|
| 1 | Annual amount of electricity exported to the national grid | +10.00% | 13.22% | Lower than the benchmark |
| | | -10.00% | 10.71% | Lower than the benchmark |
| 2 | Investment costs | +10.00% | 10.91% | Lower than the benchmark |
| | | -10.00% | 13.26% | Lower than the benchmark |
| 3 | Feed in price set by EVN | +10.00% | 13.22% | Lower than the benchmark |
| | | -10.00% | 10.67% | Lower than the benchmark |

The sensitivity shows that the project IRR is always lower than the benchmark in all cases.

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

**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"[15] hydropower projects are categorized as follows.

[14] ±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. Furthermore, ±10% is also a common practice rate for sensitivity analysis of a CDM project

[15] Construction Code regulates the basic technical standards that are mandatory for construction activities in Vietnam

**Table 7: 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 Table above, this proposed project activity falls into Group III which are similar scale and take place in a comparable environment to the proposed project activity.

**Table 8: Hydropower plants which belong to range (5MW to 50MW) were developed in Viet Nam[16]**

| No | Name | Capacity MW | Construction starting year | Commissioning year | Developed as CDM project |
|---|---|---|---|---|---|
| 1 | Nam Mu | 12 | 2002 | 2004 | No |
| 2 | Ea Krong Rou | 28 | 2003 | 2007 | No |
| 3 | Suoi Sap | 14.4 | 2004 | 2007 | No |
| 4 | Nam Tha 6 (part of "Group of Nam Tha Hydropower Project") | 6.0 | 2006 | 2007 | Yes |
| 5 | Ngoi Xan 1 (part of "Ngoi Xan Hydropower Project") | 8.1 | 2006 | 2007 | Yes |
| 6 | Na Loi | 9.3 | 2000 | 2003 | No |

Because the Na Loi hydropower project started construction from 2000[17], it is excluded from this common practise analysis. Exclusion is also applied to Nam Tha 6[18] which is the part of "Group of Nam Tha Project" and Ngoi Xan 1[19] which is the part of "Ngoi Xan Hydropower Project". . Thus, only 3 projects are relevant in this analysis.

The comparison of the three remaining hydropower plants and the proposed project activity is presented in Table below.

**Table 9: Hydropower plants which belong to group III ($5 < P_{dm} \leq 50$ MW) were developed in Viet Nam**

| No | Name | Capacity MW | Elec. outputs $10^3$ MWh | Load factor (%) | Construction starting year | Commissioning year | Investor during the investment and construction period |
|---|---|---|---|---|---|---|---|
| **0** | **The proposed project** | ***29*** | ***120.52*** | ***47.0***[20] | **2010** | **2012** | ***Song Bung Joint Stock Company*** (private owned company) |

[16] List of power plants supplied by Institute of Energy
[17] http://thuongmai.vn/Song-Da/cong-trinh-du-an/cong-trinh-thuy-dien/130-nha-may-thuy-dien-na-loi.html
[18] http://cdm.unfccc.int/UserManagement/FileStorage/HWAFNGZRTMU51V86XDB2LP40I79KJE
[19] http://cdm.unfccc.int/UserManagement/FileStorage/ZTSNIRG1O4E8YX3H2WFJD0LBA5KM7Q
[20] 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)"

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***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 | Nam Mu | 12 | 55.7 | 53.0 | Feb. 2002 | Feb. 2004 | Song Da Construction Corporation – one of the largest state-owned construction corporation belongs to Ministry of Construction[21] (Nam Mu Hydropower JSC was set up on 29 May 2003 to take over the continuing construction and to operate the Nam Mu plant)[22] |
| 2 | Ea Krong Rou | 28 | 110.7 | 45.1 | Oct. 2003 | 2007 | MienTrung Power Investment and Development Joint Stock Company (Song Da Construction Corporation and Power Company No.3 hold 85% of shares. Power Company No.3 belongs to EVN)[23]. In addition, this project had received 4 million USD from India's ODA loan[24]. |
| ***B. Invested and constructed by private companies*** | | | | | | | |
| 3 | Suoi Sap | 14.4 | 65.7 | 52.1 | Jul. 2004 | 2007 | Truong Thanh Construction Company Limited. ODA from India |

***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:

- *For projects from 1 – 2*: As can be seen in the Table above, these projects have been invested in by either large state-owned corporations or joint stock companies whose majority shares held by large state-owned corporations. These projects do not face the barriers that the proposed project faces because:

  1. The state-owned corporations mentioned above are among the largest state-owned power and construction corporations in Viet Nam. They are financed by the state budget as well as their investment activities. In 1990s, Song Da Construction Corporation have been assigned by the government to construct national hydropower plants like Hoa Binh – Song Da (1920 MW), Yaly (720 MW), Tri An (400 MW), Ham Thuan (300 MW), Thac Ba (108 MW). )….

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 = 120.52 / (29 * 8760) * 100% = 47%.

[21] http://www.songda.vn/info/Chiti%E1%BA%BFtb%E1%BA%A3ntin50n%C4%83m/tabid/368/ItemID/3799/View/Details/Default.aspx

[22] Prospectus of Nam Mu Hydropower Joint Stock Company
http://thuydiennammu.com.vn/index.php?option=com_content&view=article&id=1:gii-thiu-cong-ty&catid=2:gii-thiu-cong-ty&Itemid=2

[23] http://vincomsc.com.vn/vi/Pages/ReportFileDownload.aspx?id=8338

[24] http://www.mientrungpid.com.vn/?page=13

And from 2000, Song Da Corporation had been studying and investing in a series of hydropower plants like: Ry Ninh 2, Na Loi, Can Don, Se San 3A…[25] Therefore, they have substantial experiences in designing, investing, constructing and operating hydropower plants.

2. The state-owned corporations mentioned above were established according to the Prime Minister's Decisions No 90/TTg and 91/TTg dated on 07th March 1994. The formulation of these corporations is to aim at developing power and construction industries in order to meet national socio-economical development goals and strategies and to implement development tasks assigned by their ministries and/or Prime Minister in certain development periods. Therefore, the key target of these corporations is to serve as the governmental tool for macroeconomic interferences rather a profit making[26].

- *Project 3*: this project has borrowed ODA soft-loan from India at a very favourable interest rate[27] while the proposed project has to take loans from domestic banks without such a favourable condition. The circumstances of this project thus clearly show that this project has not been facing a similar barrier as the proposed project.

As can be seen from the above analysis, no similar projects facing the same barriers as the proposed project have been developed without the aid of CDM.

**Implementation timeline of the proposed project activity**

The major milestones in developing the investment project and pursuing the CDM are presented in the below table.

**Table 10: Major milestones in developing the investment project and CDM application**

| Investment activities | Activities to achieve CDM registration | Time | Implication on CDM |
|---|---|---|---|
| Finalizing the Feasibility Study Report with 26 MW | | March 2009 | |
| | Signing CDM consultancy contract | 6 Oct 2009 | *Evidence for early CDM consideration* |
| Issuing Certificate of Investment by Provincial People's Committee | | 9 Oct 2009 | |
| | Achieving the Minutes of a meeting to consult public opinions (local people and local authorities) on the social and environmental impacts of the CDM hydropower project in Ka Dang commune, Dong Giang district, Quang Nam province | 16 Oct 2009 | *Evidence for early CDM consideration* |
| | Achieving the Minutes of a meeting to consult local people and local authorities on the social | 20 Oct 2009 | *Evidence for early CDM consideration* |

[25] http://www.songda.vn/info/C%C3%B4ngtr%C3%ACnhd%E1%BB%B1%C3%A1n/Th%E1%BB%A7y%C4%91i%E1%BB%87n/CTho%C3%A0nth%C3%A0nh/tabid/189/currentpage/1/Default.aspx

[26] http://vi.wikipedia.org/wiki/Tổng_công_ty_91

[27] Source: Interview with Truong Thanh Construction Company Limited and confidential documentation provided to DOE

| | | | |
|---|---|---|---|
| | and environmental impacts of the CDM hydropower project in Thanh My town, Nam Giang district, Quang Nam province | | |
| | Achieving the Minutes of a meeting to consult public opinions (local people and local authorities) on the social and environmental impacts of the CDM hydropower project in Ma Cooih, Dong Giang district, Quang Nam province | 22 Oct 2009 | *Evidence for early CDM consideration* |
| | Official letter submitting by the Provincial People's Committee to the DNA request to verify and support for the CDM project | 26 Oct 2009 | *Evidence for early CDM consideration* |
| | Notifying the proposed project activity to the DNA Viet Nam | 27 Oct 2009 | |
| | Notifying the proposed project activity to the EB | 21 Dec 2009 | |
| Finalizing FS report for capacity of 29MW | | 15 Apr 2010 | |
| **Decision of Board of Directors for investing and constructing Song Bung 6 Hydropower Project as CDM Project** | | 24 Jun 2010 | |
| Signing the Engineering, Procurement and Construction EPC contract | | 10 Sept 2010 | *Starting date of the project activity* |
| Signing the equipment contract | | 17 Nov 2010 | |
| Official document No 200/TTr-QLDN issued by Department of Industry and Trade for new capacity - 29MW | | 14 Mar 2011 | |
| Decision 1394/UBND-KTN issued by Quang Nam People's Committee for approving the new capacity – 29 MW | | 26 April 2011 | |
| | Issuing the LoA for 29 MW | 28 Sept 2011 | |

**In conclusion, the proposed project is additional.**

**B.6. Emission reductions:**

**B.6.1. Explanation of methodological choices:**

The approved consolidated baseline methodology ACM0002 Version 12.2.0 is used to calculate the emission reductions.

**I. Project emissions *($PE_y$)***

According to the ACM0002 Version 12.2.0, for most renewable power generation project activities, $PE_y = 0$. However, some project activities may involve project emissions that can be significant. These emissions shall be accounted for as project emissions shall be accounted for as project emissions by using the following equation:

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

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year y (tCO2e/yr) |
| $PE_{FF,y}$ | = | Project emissions from fossil fuel consumption in year y (tCO2/yr) |
| $PE_{GP,y}$ | = | Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (tCO2e/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 $EG_{PJ}$***

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

$$EG_{PJ,y} = EG_{facility,y}$$

Where:

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

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

***Therefore, the baseline emissions are calculated as follows:***

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

***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 Viet Nam, 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 Viet Nam 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; or

b) Simple adjusted OM; or

c) Dispatch data analysis OM; or

d) Average OM.

The method (a) can be used in the project because low-cost/must-run resources in Viet Nam 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 11: Rate of low cost/must-run sources based on generation[28]**

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | Total 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 12: 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 | 28,544,173.00 | |
| **2008** | 48,719,874.00 | 29,963,699.00 | |
| **Total** | **130,259,574.00** | **84,210,790.00** | **0.6465** |

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

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

**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 Viet Nam electricity grid ($AEG_{total}$) in 2008 is 74,689,635.97 MWh then 20% of the total output of Viet Nam 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 Viet Nam 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, and transport). 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 $y$ ($tCO_2e/y$). |
| $BE_y$ | Baseline emissions in year $y$ ($tCO_2e/y$) |
| $PE_y$ | Project emissions in year $y$ ($tCO_2/y$). |

**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: | ACM0002 Version 12.2.0 |
| 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 "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 $\boldsymbol{EF}_{grid,CM,y}$ |

| **Data / Parameter:** | $\mathbf{EF}_{grid,BM,y}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Building margin $CO_2$ emission factor for grid connected power generation in year *y* calculated using the "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 $\boldsymbol{EF}_{grid,CM,y}$ |

| **Data / Parameter:** | $\mathbf{EF}_{grid,CM,y}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Combined margin $CO_2$ emission factor for grid connected power generation in year *y* calculated using the "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 29 MW and a new reservoir with surface ($A_{PJ}$) of 39.8 ha, thus $A_{BL} = 0$ and $Cap_{BL} = 0$.

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

$$PD = \frac{C_{apPJ} - C_{a\,pBL}}{A_{PJ} - A_{BL}} = \frac{29 \times 10^6 - 0}{39.8 \times 10^4 - 0} = 72.90 \ (W / m^2)$$

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 118,712 MWh/yr

$EF_{grid,CM,y}$ = 0.5764 $tCO_2$/MWh

Therefore:

$$BE_y = 118{,}712 \text{ x } 0.5764 = 68{,}425 \ (tCO_2/yr)$$

**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:

$$ER_y = BE_y - PE_y$$
$$= 68{,}425 - 0 = 68{,}425 tCO_2/year$$

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

The estimated emission reduction of the project activity is provided in Table 14.

**Table 13: 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 $CO_2e$) |
|---|---|---|---|---|
| 2013 (01/01/2013-31/12/2013) | 0 | 68,425 | 0 | 68,425 |
| 2014 | 0 | 68,425 | 0 | 68,425 |
| 2015 | 0 | 68,425 | 0 | 68,425 |
| 2016 | 0 | 68,425 | 0 | 68,425 |
| 2017 | 0 | 68,425 | 0 | 68,425 |
| 2018 | 0 | 68,425 | 0 | 68,425 |
| 2019 (01/01/2019 - 31/12/2019) | 0 | 68,425 | 0 | 68,425 |
| **Total** (tonnes of $CO_2$ e) | **0** | **478,975** | **0** | **478,975** |

**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 project connection point so $EG_{y, export}$ is excluded the electricity used for internal consumption and losses. |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 118,712 |
| 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 hydropower plant by the positive direction. The readings of electricity meter will be hourly measured 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 periodically. |
| Any comment: | For $EG_{facility, y} = EG_{y, export} - EG_{y, import, 110kV}$ |

| Data / Parameter: | $EG_{y, import, 110kV}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity supplied by the 110kV grid to the proposed hydropower plant |
| Source of data to be used: | Direct measurement at the project connection point |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 0 |
| 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 by the grid to the proposed hydropower plant by the reverse direction. The readings of electricity meter will be hourly measured 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 periodically. |
| Any comment: | For $EG_{facility, y} = EG_{y, export} - EG_{y, import, 110kV}$ |

| Data / Parameter: | $EG_{facility, y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Net electricity supplied by the proposed hydropower plant to the national grid |
| Source of data to be used: | Calculating from $EG_{y, import, 110kV}$ and $EG_{y, export}$ |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 118,712 |
| Description of measurement methods and procedures to be applied: | Calculating by subtracting $EG_{y, import, 110kV}$ from $EG_{y,export}$. 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 |
| Any comment: | For CERs calculation |

| Data / Parameter: | $A_{PJ}$ |
|---|---|
| Data unit: | $m^2$ |
| Description: | Area of the reservoir measured in the surface of the water, after the implementation of the project activity, when the reservoir is full. |
| Source of data to be used: | Project site. |
| Value of data applied | |

| | |
|---|---|
| for the purpose of calculating expected emission reductions in section B.5 | 398,000 |
| Description of measurement methods and procedures to be applied: | Measured from topographical surveys and maps yearly |
| Monitoring frequency | Yearly |
| QA/QC procedures to be applied: | The uncertainty level of this data is low. |
| Any comment: | For the calculation of PD |

| **Data / Parameter:** | **$Cap_{PJ}$** |
|---|---|
| Data unit: | W |
| Description: | Installed capacity of the hydro power plant after the implementation of the project activity. |
| Source of data to be used: | Project site |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 29,000,000 |
| Description of measurement methods and procedures to be applied: | Manufacture's nameplate |
| Monitoring frequency | Yearly |
| QA/QC procedures to be applied: | The capacity of this project will not be changed. |
| Any comment: | Use for calculating the power density |

### B.7.2. Description of the monitoring plan:

According to Version 12.2.0 of ACM0002, there is no need to monitor project emissions due to leakage under this project activity is zero.

Although the power density of the project is higher than 10 W/m$^2$, the surface area of the reservoir will be monitored annually. It will be taken by collecting photographic evidence of the surface level when the project becomes operational. This photographic evidence will be compared with the design reservoir dimensions to confirm whether or not the actual surface area substantially deviates from the design surface area.

The baseline emission factor of Viet Nam National Grid ($EF_{grid,CM,y}$) is fixed ex-ante (detail in Section B.6), therefore the main data to be monitored is *EGy,* $EG_y$ will be calculated according to this formula below*:*

$$EG_{facility,y} = EG_{y,\ export} - EG_{y,\ import,\ 110kV}$$

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 back-up system will be used in case of failing of the main meter.

Data from the operating meters will be monitored continuously and recorded hourly. The electronic data will be stored in the meters and computers. 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 protocol of the amount of power fed into the grid since the last protocol/start of operation of the power plant.

This protocol 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: 03/10/2011

*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:

10/09/2010 (Starting date of construction)

This is the date of signing the EPC contract that is the earliest contract signed by the project owner to commit for the project's expenditures of the Song Bung 6 hydropower project. 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:

37 years[29] 0 months

[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 (4,156 hrs)

| 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: |
|---|

01/01/2013 or the date of registration whatever is later

| C.2.1.2. Length of the first crediting period: |
|---|

7 years 0 months

| C.2.2. Fixed crediting period: |
|---|

| C.2.2.1. Starting date: |
|---|

Not applicable

| C.2.2.2. Length: |
|---|

Not applicable

| SECTION D. Environmental impacts |
|---|

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

As required by Article 20 of the 2005 Environment Protection Law of Viet Nam 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 dated 09 August 2006 of the Government detailing and providing guidance for the implementation of a number of articles of the Law on Environmental Protection Law of Viet Nam 2005, the Environmental Impact Assessment (EIA) for this project has been carried out. The EIA report has already been approved by the Quang Nam People's Committee on Decision No 980/ QD-UBND dated 30 March 2009.

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. Environment Impacts**

***1.1.1. Impact on land***

The proposed project will occupy 137.94[30] ha area land for arrangement of project structures, in which, the area of long-term occupied land for reservoir and plant is 89.64 ha and the balance is temporary

[30] EIA Report, p. 65

occupied land for construction period. Most of land is fallow land, protective forest land, and river land. Ecological system is not impacted significantly by the project activity.

### *1.1.2. Impacts on water flow*

The project will create a reservoir with the area of 39.8 ha. Since the reservoir regulates water level on the daily basis, and hence the water flow of Bung River will be affected insignificantly in quality. When commissioning, the reservoir will be used for the purpose of generating electricity but is also helpful to prevent floods.

### *1.1.3. Impacts on ecological system*

The Song Bung 6 Hydropower Project does not cross-out any natural conservation areas, national forests or specialized forest. After constructing, the forest area which is temporarily occupied will be reforested[31].

### *1.1.4. 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. There are no people living around site area.

## 1.2. Socio-economic impacts

### *1.2.1. Negative impacts*

Negative impacts are the occupied land (137.94 ha), but most of them are fallow land and river or stream lands. The occupied lands will be compensated according to requirements from Viet Nam Government and approval from Quang Nam People's Committee.

### *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 sanitary waste or oil to the river

[31] EIA Report, p.95

- Clearing the reservoir foundation: 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.
- All transport equipment/vehicles and machines must have operational certifications issued by the Directorate for Standards and Quality.
- Regular monitoring of air quality included dust, CO, $NO_2$, $SO_2$… at stations in the construction area.

- *On noise*
- Enforcement of using ear protection during construction period.
- Arrange works on day time, constrain working by night

- *Waste collection and treatment*
- Implement regular collection and treatment of solid and liquid wastes, including the construction of a dumping area
- Conduct awareness on the environmental protection for workers and local people.

- *On flora and fauna*
- All work will be carried out in a manner such that damage or disruption to vegetation is minimized. After completion of construction activities, temporarily occupied areas will be re-vegetated.
- Provision of heating and cooking options without use of wood.
- Provision of environmental training on environmental management issues
- Environmental protection by guards, capacity building of forest rangers, and control the illegal activities.

### *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:

According to the regulation on development of CDM projects in Viet Nam, the following stakeholders have been consulted:

- Quang Nam People's Committee has approved EIA report via Decision No. 980/ QD-UBND dated 30 March 2009
- People Committee of Quang Nam province (highest local authority): the People Committee of Quang Nam was informed about the CDM development of the project and supported to develop this project as a CDM project activity via issuance of the official verification letter no 3961/ UBND-KTN which was sent to Viet Nam DNA on 26 October 2009
- Local people in the project area in Ma Cooih commune and Ka Dang commune, Dong Giang district, and Thanh My town. Nam Giang district, Quang Nam province.

Besides, the local people of Ma Cooih and Ka Dang communes and Thanh My town were involved in the consultation process.

One week before the stakeholders meetings regarding the proposed project, the stakeholders were informed about project by public radio and notices at the Ma Cooih and Ka Dang Communal People's Committee's offices and Thanh My Town People's Committee's office. At the same time they were invited to the official meetings with the project owner to provide their comments. On 16$^{th}$, 20$^{th}$ and 22$^{nd}$ of October 2009, a meeting 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 Council: The members of Commune People Council are elected by residents in commune. So the Council opinions officially represent for opinions of the local people.
- Town's People Council: The members of Town People Council are elected by residents in town. So the Council opinions officially represent for opinions of the local people.
- Commune's People Committee (CPC): CPC is the lowest administration level in Viet Nam administrative hierarchy. Chairman of CPC is elected by the Commune's People Council, so he well represents the commune's interest.
- Town's People Committee (TPC): TPC is the lowest administration level in Viet Nam administrative hierarchy. Chairman of TPC is elected by the Town's People Council, so he well represents the town's interest.
- Commune's communist party committee secretary: this is one of the key government bodies in making development strategies at the communal level.
- Town's communist party committee secretary: this is one of the key government bodies in making development strategies at the town 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:

- The proposed hydropower project is a clean industrial project and will contribute to socio-economic development of the project's area;
- The project will contribute to conservation of forest and environmental protection; and
- The local people expect that the project activity will employ local people for construction as well as operation phases if suitable and will minimise negative impacts during the construction phase.
- 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

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

To address the requests from local people, the project's owner committed to:

- use local human resources for appropriate jobs in the construction and operation phases;
- seriously apply and implement mitigation activities as stated in the EIA report in order to minimise negative impacts on local environment.
- comply with existing regulation on compensations and agreements with households to implement a fair and reasonable plan. The project owner has negotiated and reached an agreement with each impacted households. Then a compensation budget and plan has been approved by the Department of Nature Resources and Environment at the Decision 149/QD-TNMT and 150/QD-TNMT. The payment to each household is made under the supervision of the Compensation Board which has representatives from government offices and local people.

## Annex 1

## CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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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

Data sources using to calculate $EF_{CM, grid}$ has been referred to the published data of DNA Viet Nam according to the link below:

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

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### Introduction

The process of calculating the Viet Nam 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 Viet Nam (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 Viet Nam 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 Viet Nam.

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 17. 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 Viet Nam 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 Viet Nam, 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. Viet Nam grid-connected power generation**

**Table 27: 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 Viet Nam 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 Viet Nam 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: $m^3$) | 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** | **28,544,173.00** |
| **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 | 28,544,173.00 | 29,963,699.00 | **84,210,790.00** |

**Table 23: 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 | 28,544,173.00 | |
| **2008** | 48,719,874.00 | 29,963,699.00 | |
| **Total** | **130,259,574.00** | **84,210,790.00** | **0.6465** |

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

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

20% of the total output of Viet Nam 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 |
| Ca Mau 1&2 | 2007 | Gas | 647.24 | 2,106,807.24 | 1,431,048 |

| | | | | | |
|---|---|---|---|---|---|
| | | 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** |
| ***Calculation results of BM emission factor*** | | | | | |
| Total emission | | | 8,362,386.09 ($tCO_2$) | | |
| Total electricity generation | | | 16,514,761.12 (MWh) | | |
| $BM_{2008}$ | | | **0.5064** | | |

### 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 Viet Nam 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 under UNFCCC.

## ANNEX 4

## MONITORING INFORMATION

### A. Description of technical equipment

The metering system will be installed at the connecting point. The metering system includes the main system and a back-up system. The power meters are digital and bi-directly with high accuracy (0.2s for main meters and 0.5s for back-up meters).

The meter type is three phases electronic and technical details will 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 the monitoring group is as follows:

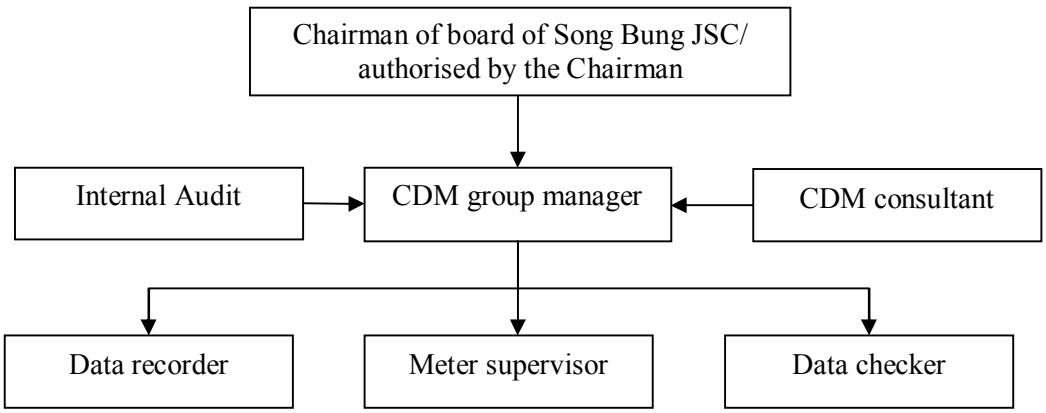


**Figure 4: Structure of the monitoring group**

The responsibilities of each person involved are elaborated as follows:

| Person | Responsibility |
|---|---|
| Chairman of board of Song Bung JSC/authorised by the Chairman | Check and sign the monitoring report annually. |
| CDM group manager | Managing the whole CDM business of Song Bung 6 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 proposed project are as follows:

- ✓ Data recorder, meter supervisor from Song Bung 6 HPP with staff from EVN should read and collect data from main power meter on the first day of every month, the result will be signed by both parties and kept respectively;
- ✓ Song Bung JSC provides electricity sales invoice to EVN, and keeps the copy of invoice;
- ✓ EVN provides electricity sales invoice to Song Bung 6 HPP (if available);
- ✓ Song Bung JSC provides the record of main, back-up power meter, copy of invoices to VNEEC.

VNEEC will be responsible for cross-checking all data from the record of main, back-up power meter and copy of invoices, also preparing the monitoring report for verification process of DOE.

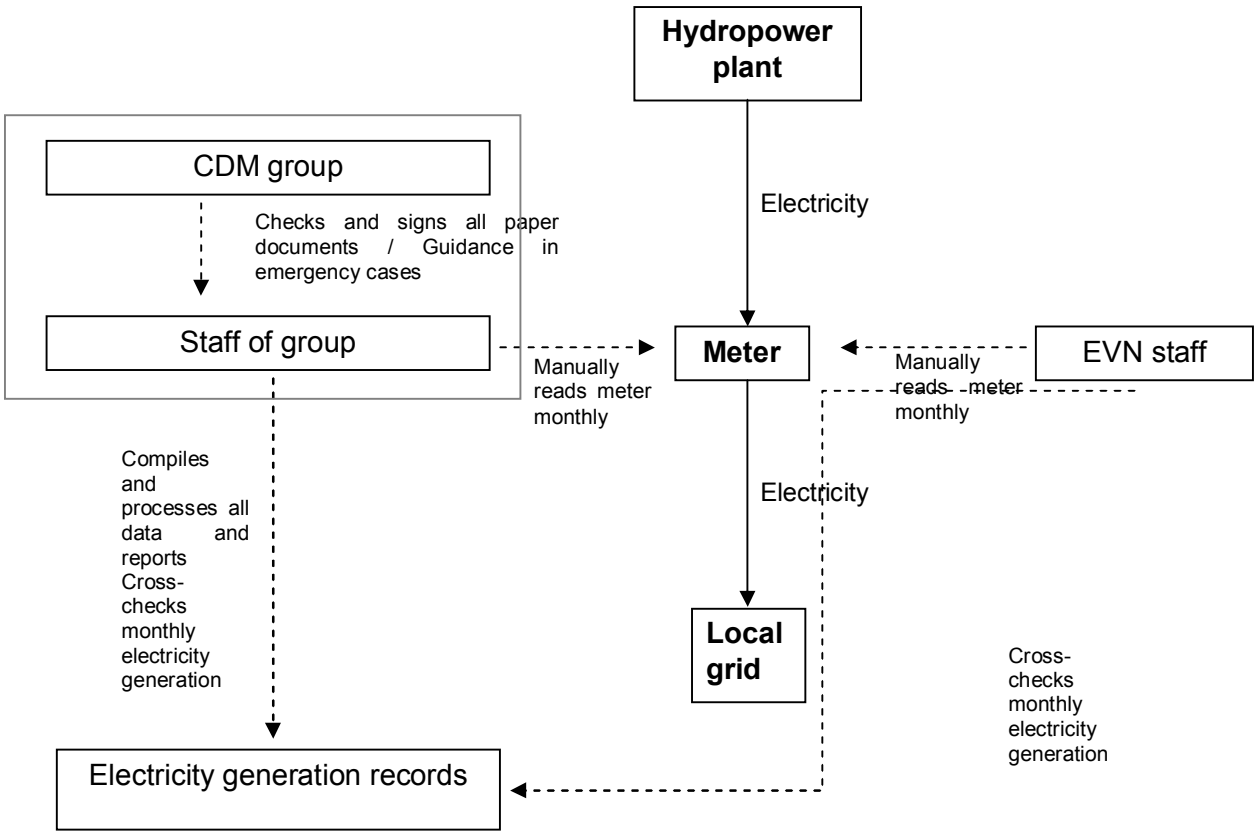


**Figure 5: Monitoring process**

**D. Calibration of metering equipment**

The meters will be calibrated and verified pursuant to national standard. According to the Decision No 65/2002/QD-BKHCNMT[32], calibration and verification for 3 phase meters need to be conducted periodicallyby the third party once during project operation. After every calibration, the meters will be sealed so that no illegal interference is possible.

**E. Data recording and archiving procedures**

- The CDM group appointed by Song Bung 6 power 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 6 power plant shall keep the copy of electricity sales/purchase invoices (the original electricity sales/purchase invoices shall be kept by Finance Department of SONG BUNG JSC).
- In order to help verifiers obtain documents and information related to the emission reduction of the proposed project, SONG BUNG JSC 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 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, by taking a conservative approach. In doing so, the chief of division shall seek guidance from VNEEC.

**G. Training**

Before the start the crediting period 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.

[32] Decision No 65/2002/QD-BKHCNMT[32] 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".