Project design document form for CDM project activities

(Version 08.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Hedcor Sibulan 42.5 MW Hydroelectric Power Project (the "Project")
Version number of the PDD	Version 04
Completion date of the PDD	23/01/2017
Project participant(s)	Hedcor Sibulan, Inc.
Host Party	Republic of the Philippines
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	Methodology ACM0002-Version 06: *Consolidated baseline methodology for grid-connected electricity generation from renewable sources*
Sectoral scope(s) linked to the applied methodology(ies)	Sectoral Scope 01: Energy industries (renewable - / non-renewable sources).
Estimated amount of annual average GHG emission reductions	95,174 tCO_2

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The Project, which shall be undertaken by Hedcor Sibulan Inc. (HSI) as the project company, is a cascade development of two power plants; namely, an upstream Sibulan Plant A with an installed capacity of 16.5 MW and a downstream Sibulan Plant B with an installed capacity of 26MW. The combined average annual energy is estimated to be 209,635 MWh. The Plants are essentially of the run-of-river type that include an intake weir, short tunnel, surface pipeline, desander, headpond, high pressure surface penstock, surface power plant, substation, switchyard, and transmission line. The Plants will each house two Pelton turbines and generating units suitable for local and remote control.

The purpose of the Project is to generate carbon neutral electricity harnessing the water of the Sibulan and Baroring Rivers to generated electricity. The energy to be generated will be exported to the Mindanao grid. In doing so, the Project will displace fossil fuel-fired power generation of the same grid, contributing to a reduction of greenhouse gases (GHGs). When the Project is fully operational, it is expected to contribute to emission reductions of 95,174 tCO_2 annually and 666,218 for the 7-year crediting period.

The Project will also contribute to the sustainable development of the Philippines and to the host communities.

At the national level, the use of indigenous renewable resources for power generation will reduce the country's reliance on imported fuel, which will not only reduce associated environmental impacts, but also contribute foreign currency savings. This is consistent with the Department of Energy's Philippine Energy Plan1[1], whose stated goals include energy independence and increase in the use of renewable energy.

Locally, the Project will contribute significantly to the social and economic situation of the local residents, particularly the indigenous people of Bagobo-Tagabawa, through job opportunities during construction and during operation, local businesses as a result of the activities in the area, and the implementation of a social development plan.

The Project is a run-of-river hydroelectric plant, it does not involve construction of large dam, therefore the perceived negative impacts often associated with the hydroelectric plants' large dams such as the relocation of communities and residents as well as transfer of waterways will not occur.

It is confirmed that the Project is not a CPA that has been excluded from a registered CDM PoA as a result of erroneous inclusion of CPAs.

A.2. Location of project activity

A.2.1. Host Party

Republic of the Philippines

A.2.2. Region/State/Province etc.

Davao Region, Mindanao

[1] *2006 Plan Update http://www.doe.gov.ph/PEP/I%20PEP%20Overview.pdf*

A.2.3. City/Town/Community etc.

Barangay Sibulan, Sta. Cruz, Davao Del Sur.

A.2.4. Physical/Geographical location

The Project Site, consisting of the upper and lower project areas, is located approximately 19 kilometers from the southeastern boundary of Davao City. The various infrastructures constituting the Project are expected to be spread around the barangays of Sibulan, Tibolo and Darong. The lower project area where Plant B will be constructed is about 45 minutes away from the city and may be reached by vehicular access from the Davao City-General Santos National Highway and through a gravel road from Brgy. Inawayan. However, vehicular access is only up to Brgy. Sibulan proper and to Sitio Kabarisan which are 9.9 km and 12.5 km from Barangay Inawayan respectively. From these points, access to the Sibulan River tributaries and to the location of Plant A at the confluence of the Baroring and Sibulan River is by foot through moderate to steep rolling hills and plateaus. The upper project area, where Plant A will be constructed, is about two hours away from the city or one hour and 15 minutes from Plant B. The Plant A project area can be reached by vehicular access via the Davao-General Santos National Highway and through a 30-km gravel road from Digos City to Barangay Kapatagan at the foothills of Mt. Apo; and from Brgy. Kapatagan, access to the Site is by foot or horse ride through precipitous cliffs and river channels.

The Sibulan River watershed is largely devoid of forest cover. Only the slopes along the river are vegetated with second growth forest. The rest of the area is vegetated largely with cogon and patches of agricultural land planted mainly of potatoes, corn, carrots and other crops. Other land uses are for settlements and service centers such as schools and health centers.

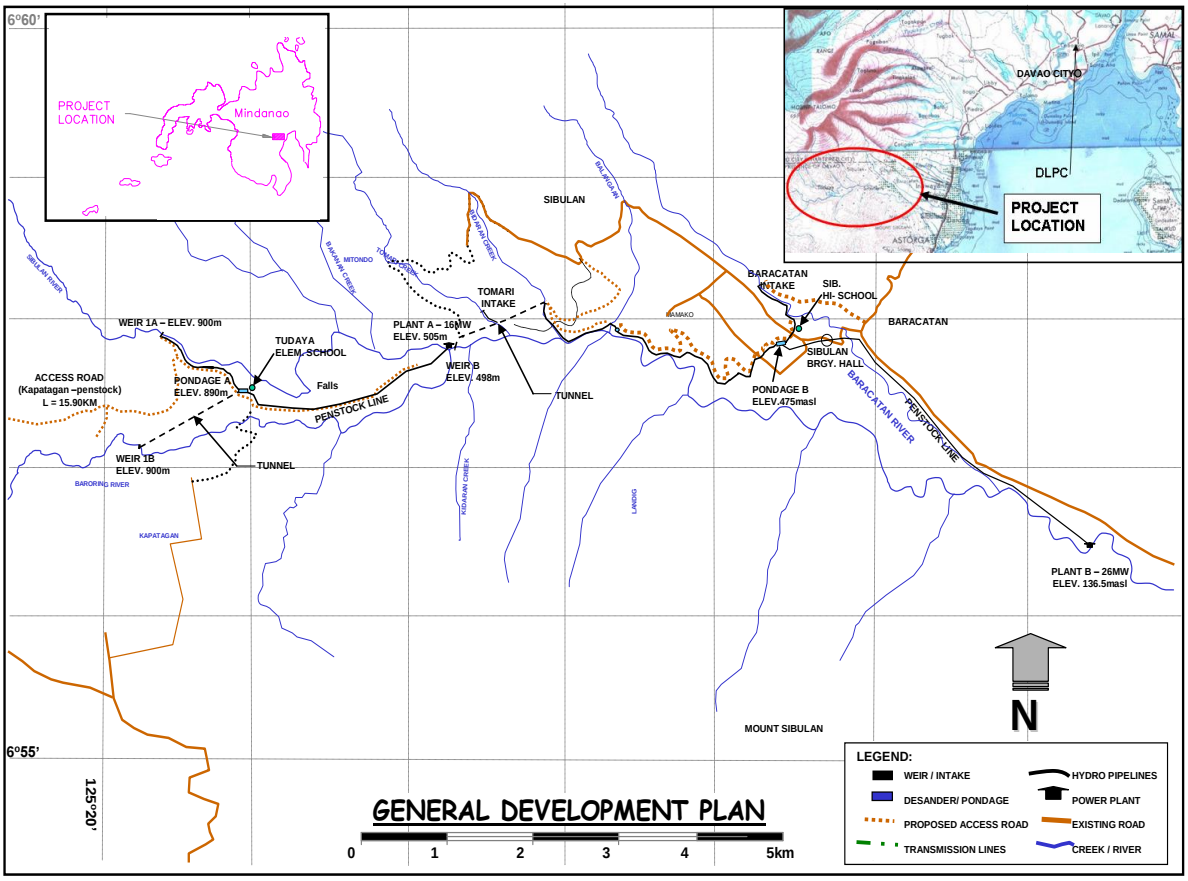
Surface water bodies in the area consist of the two major rivers Baroring and Sibulan and their tributaries and smaller creeks that drain towards the Inawayan-Sirawan area. All of these drainage systems empty its load towards Davao Gulf. Domestic water supply for the upland areas particularly Sitios Pogpog and Tudaya is sourced from a spring located at Garak developed for this purpose. The drainage system in the area is generally fan-shaped particularly along the broad foot slopes. The drainage system at the uppermost section (tributaries of Baroring and Sibulan Rivers) exhibit a radial trellis, and parallel patterns.

The eastern slopes are characterized by a broad gentle slope, which has moderately deep to deeply incised river channel topography. This becomes moderately rugged to rugged further west and south especially along the slopes of the volcanic cones. Plateau like ridges with low lying slopes are well developed.

The lower project area on the Plant B section of the project is reached by vehicular access from the Davao City – General Santos National Highway and through a gravel road from Barangay Inawayan. Vehicular access is up to Brgy. Sibulan proper and to Sitio Kabarisan which are 9.9 km. and 12.5 km. from Brgy. Inwayan, respectively. From these points, access to the Sibulan River tributaries and to the location of Plant A at the confluence of the Baroring and Sibulan rivers is by foot through moderate to steel rolling hills and plateaus.

The Plants are proposed to be connected to the DLPC system through a 69 KV transmission line about 34 km. long to DLPC’s ERA Main Substation.

Figure 1 Map indicating Sibulan plant site



The geographical coordinates for the plants are as follows:

- Plant A: 6-57-45.57N / 125-22-17.03E
- Plant B: 6-56-25.50N / 125-26-27.17E

A.3. Technologies and/or measures

The Project, which shall be undertaken by HSI as the project company, is a cascade development of two power plants; namely, an upstream Sibulan Plant A with an installed capacity of 16.5 MW and a downstream Sibulan Plant B with an installed capacity of 26MW. The combined average annual energy is estimated to be 209,635 MWh. The Plants are essentially of the run-of-river types that include an intake weir, short tunnel, surface pipeline, desander, headpond, high pressure surface penstock, surface power plant, substation, switchyard, and transmission line. The Plants will each house two Pelton turbines and generating units suitable for local and remote control.

Table 1: List of Main Installed Technologies as at August 2016

Equipment	Manufacturer	Age	Average Lifetime	Load factor	Efficiency[a]
2 x 8.25MW turbo generator (Sibulan A)	SOCOIN (Voith Siemens)	Approx. 6.5 years	25 years	Approx. 56%	80.06% - 87.94%
2 x 13MW turbo generator (Sibulan B)	SOCOIN (Voith Siemens)	Approx. 6 years	25 years	Approx. 56%	80.69% - 87.98%

[a] Efficiencies are guaranteed efficiencies provided by the manufacturer, and depends on the water flow as well as number of units operating at the same time.

Table 2: List of Monitoring Equipment as at August 2016[2]

Equipment	Manufacturer	Accuracy Class	Asset Owner[a]
Electricity meter (monitoring, main)	AMETEK	0.2	NGCP
Electricity meter (monitoring, backup)	ELSTER	0.2	NGCP
Electricity meter (monitoring, temporary)	Landis+Gyr	0.2	NGCP

[a] The electricity meters at the grid connection point are owned by National Grid Corporation of the Philippines (NGCP).

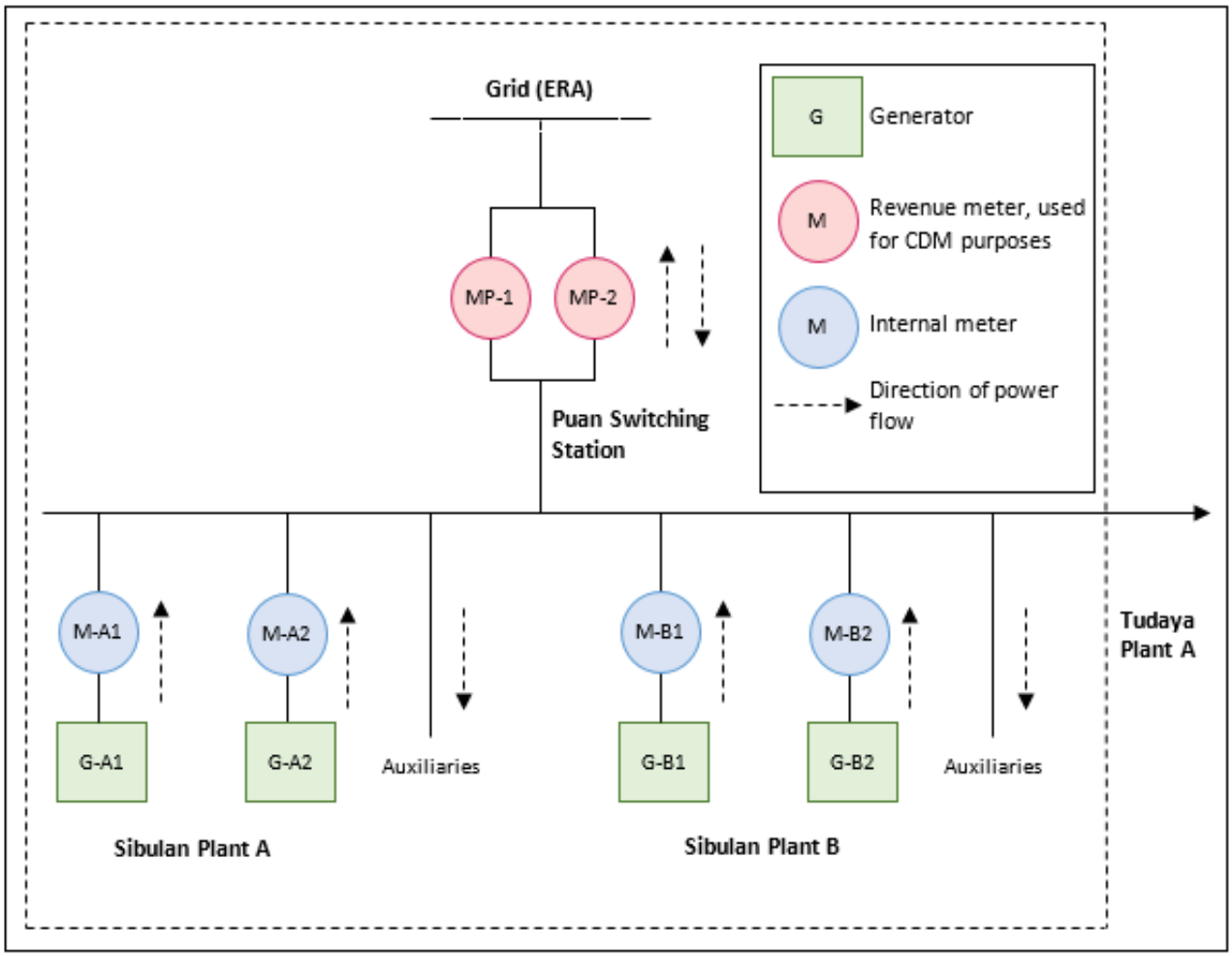


Figure 2: Main Technologies and Monitoring Equipment[3]

There are no individual facilities to be listed under the existing scenario prior to the implementation of the project activity (the baseline), as the scenario is grid electricity generation. In the baseline, the same level of service, i.e. 209,635MWh, would be supplied by other grid-connected power plants.

[2] It is clarified that future changes in monitoring equipment, owned by the grid company NGCP and typically having a lifetime of 3~5 years, will not constitute a change of project plans.

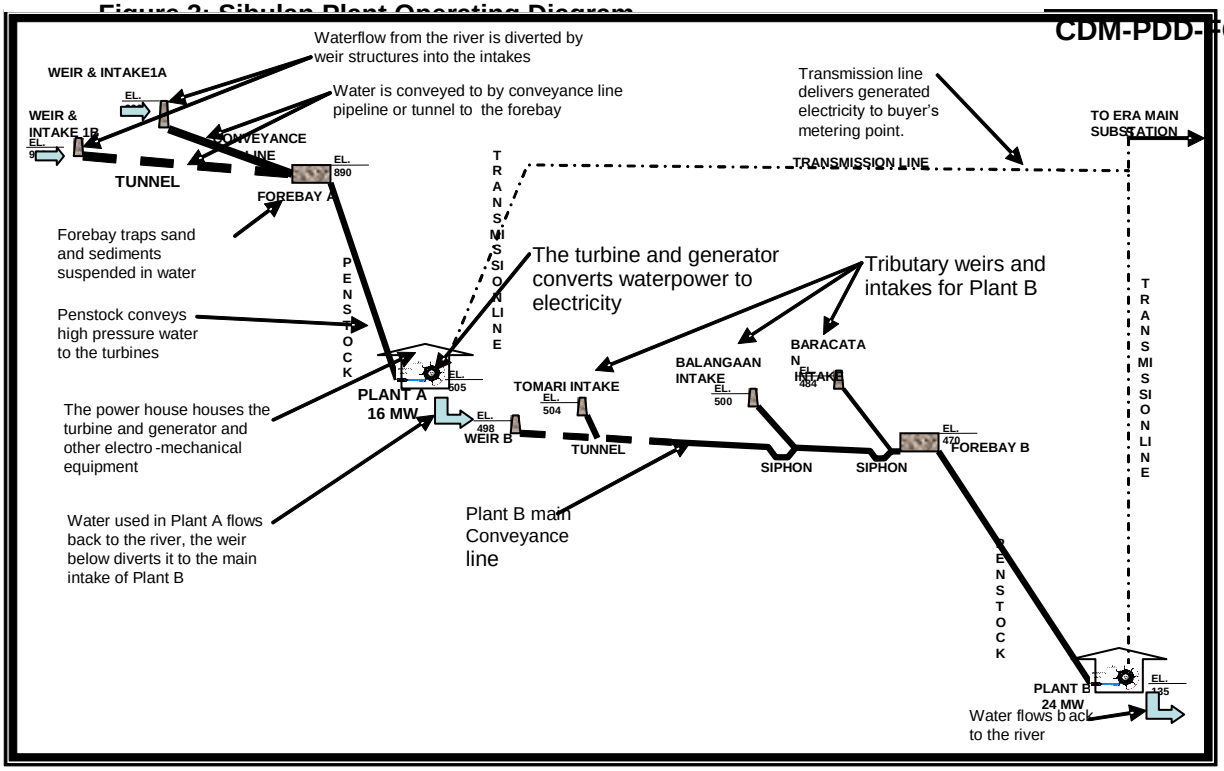
[3] The figure represents the normal metering arrangement. A temporary metering arrangement is currently in place at the request of NGCP. The permanent and temporary meter arrangements are elaborated in Section B.7.

The Plants are designed with the capacity to impound water such that it can operate at maximum capacity during the peak hours of the day. Plant A has a pondage volume of 70,000 m^3 while Plant B has a pondage volume of 50,000 m^3. Since the Plants are cascaded, any amount of stored water at Plant A when released has a corresponding effect on Plant B. Likewise, when Plant A is filling up, Plant B does not operate at flows equivalent to the amount being stored at Plant A. The amount of stored water in the pondage plus run-off river flow produces the peak capacity during the 8-hour period of release, which coincides with the peak hours of the off-taker, DLPC. The peak-hour operation of the Plants takes advantage of the Time-of-Use rates provided in the DLPC PSA resulting in higher generation revenue.

The Project Site, consisting of the upper and lower project areas, is located approximately 19 kilometers from the southeast boundary of Davao City. The Plants are proposed to be connected to the DLPC system through a 69 KV transmission line about 34 km. long to DLPC's ERA Main Substation. The various infrastructures constituting the Project are expected to be spread around the barangays of Sibulan, Tibolo and Darong. The lower project area where Plant B will be constructed is about 45 minutes away from the city and may be reached by vehicular access from the Davao City-General Santos National Highway and through a gravel road from Brgy. Inawayan. However, vehicular access is only up to Brgy. Sibulan proper and to Sitio Kabarisan which are 9.9 km and 12.5 km from Barangay Inawayan respectively. From these points, access to the Sibulan River tributaries and to the location of Plant A at the confluence of the Baroring and Sibulan River is by foot through moderate to steep rolling hills and plateaus. The upper project area, where Plant A will be constructed, is about two hours away from the city or one hour and 15 minutes from Plant B. The Plant A project area can be reached by vehicular access via the Davao-General Santos National Highway and through a 30-km gravel road from Digos City to Barangay Kapatagan at the foothills of Mt. Apo; and from Brgy. Kapatagan, access to the Site is by foot or horse ride through precipitous cliffs and river channels.

Water will be diverted from the rivers by low concrete weirs. Diverted water from the weirs will be conveyed by short tunnels constructed through geologically competent rock. The remainder of the low-pressure conveyance systems will comprise of welded steel pipes laid above ground. The plants will have individual rock-traps, desanders and headponds which will ensure that the water to be delivered through the turbines will be essentially sediment-free, thus preventing erosion. The high-pressure penstocks will also comprise of welded steel pipes laid above ground. The power plant buildings will be located at an elevation of about 1.5m above the estimated flood level with a return period of 1,000 years. Multi-jet pelton type turbines will be used. This type of turbine only has few moving parts and has high efficiency even at derated part load operation.

Figure 2: Sibulan Plant Operating Diagram



No major dam or reservoir will be constructed. Instead, the plants will utilize small, off-river head ponds which will regulate the output daily.

The diverted water will be routed through a pipeline system that will pass through a forebay. In the forebay, the water will be removed of sand and silt, and will then be conveyed down further by a penstock to the hydraulic turbines installed at the powerhouse. The water will impinge on the runner blades of the turbines causing a rotating motion and will convert the hydraulic energy to mechanical energy. Since the turbines are directly coupled to the generators, such energy will be converted into electrical energy.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of the Philippines	Hedcor Sibulan, Inc.	No
United Kingdom of Great Britain and Northern Ireland	Hedcor Sibulan, Inc.	No
Netherlands	Klinkenberg Traders B.V.	No

HSI is the special purpose company organized to enter into contracts for the development, construction, and operation of the Project. HSI is 100% owned by Philippine Hydropower Corporation (PHC).

It is noted for clarity that HSI's sister company, Hedcor Inc. (Hedcor), which is also owned by PHC, developed the project for HSI. In the PDD, HSI and Hedcor are mentioned interchangeably. Hedcor has experience in the development, design and operation of clean and renewable energy projects, particularly hydroelectric power plants. It owns and operates ten (10) mini hydroelectric power plants in Northern Luzon and five (5) mini hydroelectric power plants ranging from 0.30 MW to 1.9MW in Davao City, Mindanao, with a total installed capacity of 38.22 MW. Hedcor is considered the largest developer and operator of mini hydroelectric power plants in the Philippines.

A.5. Public funding of project activity

The Project does not involve public funding.

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

B.1. Reference of methodology and standardized baseline

The approved baseline and monitoring methodology ACM0002-Version 06: *Consolidated baseline methodology for grid-connected electricity generation from renewable sources* ("ACM0002") is applied.

For the purpose of establishing additionality, Version 03 of the *Tool for the demonstration and assessment of additionality* ("Additionality Tool") is also used.

B.2. Applicability of methodology and standardized baseline

The Project meets all applicability conditions of ACM0002-Version 06, as follows:

- The Project is a grid-connected renewable power generation project activity which involves a capacity addition from run-of-the-river hydro power plants.

- It does not involve switching from fossil fuels to renewable energy at the site of the project activity. The Project is a greenfield power project.

- The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available. The relevant grid for the Project is the Mindanao grid, one of the three regional grids of the Philippines. There is no interconnection between that grid with any other grid, and information on the characteristics of the grid is available from the Department of Energy (PDOE) and National Power Corporation (NPC).

B.3. Project boundary

As per ACM0002, the following sources and gases are included in the project boundary.

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Grid electricity generation	CO_2	Yes	Consistent with ACM0002-Version 06
		CH_4	No	
		N_2O	No	

The spatial extent of the project boundary includes the site of the Project and all power plants connected physically to the electricity system that the Project is connected to. For the Project, the suitable grid will be the Mindanao grid, which is one of the three regional grids in the Philippines. There is no interconnection between the Mindanao grid and the two other Luzon and Visayas grids.

The below diagram delineates the project boundary.

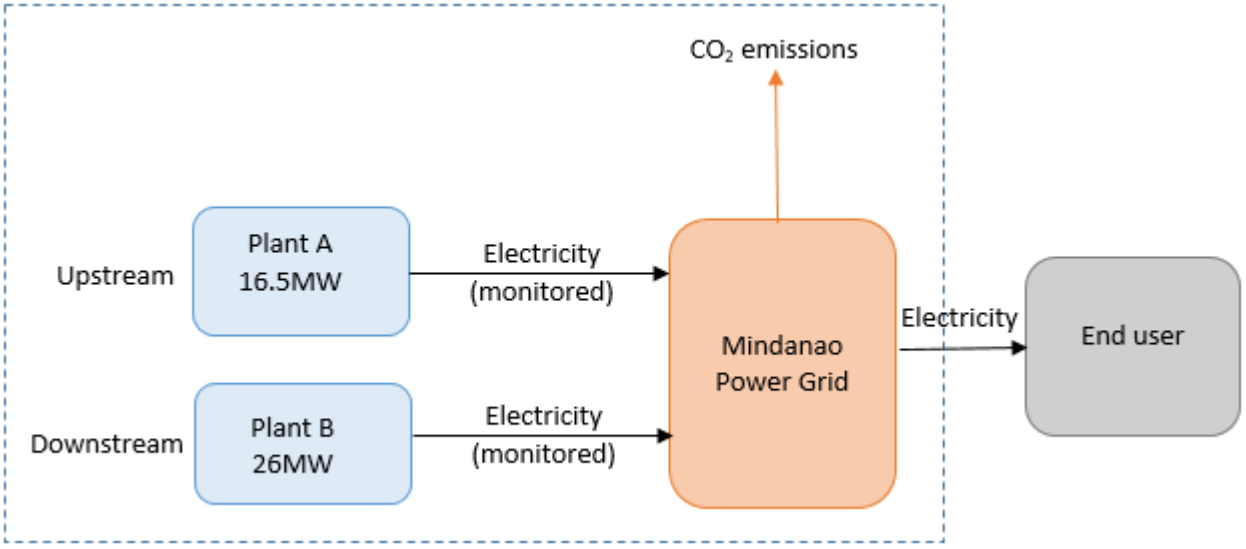


Figure 4: Flow diagram of the project boundary

B.4. Establishment and description of baseline scenario

The most plausible baseline scenario is identified in two steps. The first is the identification of all plausible alternatives. The second is the narrowing down of the plausible alternatives though assessment of barriers.

Hedcor, Inc. through HSI is a company specializing in hydro power project development in the Philippines. Therefore, there are only two real and credible alternatives available to the project participants or similar project developers that provide outputs or services comparable with the Project. These are:

> Alternative A: The proposed project activity undertaken without being registered as a CDM project activity; and
>
> Alternative B: Continuation of the current situation (no project activity or other alternatives undertaken).

Alternative A, wherein the proposed project activity is implemented without the assistance of the CDM, can be ruled out as a credible alternative. As demonstrated quantitatively in Section B.5 below, the Project, in the absence of additional revenue is clearly not financially attractive for the project proponent. This is consistent with the fact that no hydro power project, either small or large, has been implemented in Mindanao since 1998. The last hydro project of a similar scale to the Project, the 80MW Agus 1 project, commenced operation in 1994; the 68MW Tagoloan hydropower plant bided out by the National Power Corporation remains to be undeveloped and except for this Project, no hydropower plant is being developed by other proponents. Furthermore, this will be the first time that Hedcor will design and develop a project of this scale. The total project cost, totalling approximately 5.0 billion pesos, has a huge cashflow requirement and cash from Hedcor operations is not sufficient to fund the Project, not even Hedcor's Php 3 billion assets will not be sufficient to fund the Project.

Therefore, the remaining Alternative B, which is the non-implementation of the Project and the continued electricity generation from the Mindanao grid, is determined to be the baseline scenario.

B.5. Demonstration of additionality

The additionality of the Project is established based on the Additionality Tool. Of the investment analysis (Step 2) and barrier analysis (Step 3), the investment analysis has been chosen as an appropriate method of establishing additionality.

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

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

The following possible alternatives to the Project were identified in Section B.4 above.

- The proposed project activity undertaken without being registered as a CDM project activity; and

- Continuation of the current situation (no project activity or other alternatives undertaken).

In Section B.4, the proposed project activity undertaken without being registered as a CDM project activity was qualitatively determined as not being a plausible alternative. This will be further elaborated quantitatively in Step 2 below. The remaining alternative, non-implementation of the Project, was therefore deemed to be the plausible baseline scenario.

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

The identified alternative, the non-implementation of the Project and continued grid electricity generation, is in compliance with all applicable legal and regulatory requirements. The same is also true for the proposed CDM project activity.

Step 2. Investment Analysis

Sub-step 2a. Determine appropriate analysis method

The CDM project activity will generate financial benefits other than CDM related income, which will be in the form of power sales, therefore the simple cost analysis (Option I) cannot be used.

The Additionality Tool allows either the investment comparison analysis (Option II) or the benchmark analysis (Option III) to be used. Here, the benchmark analysis will be used. It is noted that, as stated in Section B.4, Hedcor specializes in hydro power project development and hence the investment comparison analysis is not appropriate.

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

In this analysis, the Internal Rate of Return (IRR) is considered to be the suitable financial indicator. In accordance with the Additionality Tool, the IRR to be calculated is the same as the project IRR.

The Additionality Tool stipulates that the benchmark can be derived from government bond rates, the estimated cost of financing, the required return on capital, and company internal benchmarks. In coming up with the benchmark, the government bond rate of 7.0%[4] is used. Risk premiums were added to derive the benchmark. The premiums added and deemed relevant to the Project are the following:

- Corporate borrowing premium5 1.0~1.5% → 1.0%
- Greenfield project premium 1.0~1.5% → 1.0%
- Equity premium 2.0~5.0% → 2.0%

The resultant benchmark is therefore 11.0%. This figure is realistic and conservative.

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

The table below shows the data and assumptions used in calculating the IRR for the Sibulan plant. Detailed information is provided in Annex 5.

Table 3: Parameters for calculating the IRRs for the Sibulan plants

Parameter	Value	Unit	Note
Project Life	25	years	
Generating Capacity	42.5	MW	
Electricity Export Full Year Year 1 Year 26	 209,635 92,897 1176,322	MWh/year	Prediction based on daily flow data compiled using 19 years' historical data
Electricity Tariff	4.0856	PHP/kWh	Assumed increase at 2% annually, starting from 4.0856 in 1st year. 4.0856 is agreed price, as per Power Supply Agreement
Capital Cost	5,121,000,000	PHP	
O&M Cost Full Year Year 1 Year 26	 326,622,507 136,092,711 190,529,796	PHP/year	
Corporate Tax Tax Rate Tax Holiday	 0.32 6	 fraction years	
IRR	9.68	%	

As can be seen in the table above, the resultant IRR for the Sibulan plant is 9.68%. This is below the benchmark threshold of 11.0%, and shows that the Project is not financially feasible as business-as-usual.

Sub-step 2d. Sensitivity analysis

[4] *Bloomberg, Peso-denominated Philippine government bond as of 16 Aug 2007 expiring in March 2011. This is the longest term available with takers.*

[5] *Premium for established, operating, highly creditworthy corporate entity.*

To show that the conclusion reached in Sub-step 2c holds true for reasonable variations in the input parameters, a sensitivity analysis was carried out by introducing changes to the following critical assumptions.

- The net plant utilization factor is increased by 5%. This increases the IRR to 10.39%.
- The capital cost is decreased by 5%. This increases the IRR to 10.18%.
- The O&M cost is decreased by 10%. This increases the IRR to 10.10%.
  It is noted that HSI considers that the O&M cost is prone to more fluctuations as compared to other parameters.
- The electricity tariff is increased by 5%. This increases the IRR to 10.47%.

It can be seen that the IRR will not surpass the benchmark value, even with favourable assumptions.

Step 4. Common practice analysis

Step 4a. Analyze other activities similar to the proposed project activity

The Mindanao grid is heavily reliant on hydro resources, hydro plants make up approximately 60% of the installed capacity. The following table shows the existing hydro power plants and the installed capacities.

Table 4: Existing hydro capacity in Mindanao

Plant Name	Installed Capacity (MW)
Agus 1 Unit 1	40.00
Agus 1 Unit 2	40.00
Agus 2	180.00
Agus 4	158.10
Agus 5	55.00
Agus 6	200.00
Agus 7	54.00
Agusan	1.60
Pulangi 4	255.00
Bubunawan	7.00
Talomo[6]	3.70
Other mini-hydro	3.25
Total	997.65

Source: Department of Energy (Philippines)

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

Despite the number of hydro power plants installed in Mindanao, they are not similar to the Project. The seven (7) Agus plants, ranging from 40MW to 200MW, as well as the 255MW Pulangi Plant are all owned by the National Power Corporation, the state-owned power generating company. Of the privately-owned projects, the largest in capacity is the Bubunawan Plant at 7MW.

[6] *Owned by Hedcor, Inc.*

The 2 x 40MW Agus 1 Plant is the last hydro power plant constructed which is of comparable size to the Project. It was implemented in 1994 when both the power market structure and investment climate were different compared to today. Moreover, apart from the Bubunawan hydro power plant, all other hydro power plants in Mindanao were built by the government using special loans from institutions such as the World Bank. The Project enjoys no such benefits.

The only known hydro project in the pipeline is the 1MW Sipanpang mini hydro project, which will also be implemented as a CDM project.

Such being the case, it can be concluded that there are no similar activities to the proposed project activity.

Starting dates of the project activity and validation

It is required that where the starting date of the project activity falls before the date of validation, evidence must be shown that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. As given in Section C.1.1., the starting date of the project activity is October 30, 2005, the date on which Hedcor accepted Klima's proposal to initiate CDM work.

There is ample evidence to show that HSI seriously considered the CDM from the very early stages of the project development. Discussions regarding the CDM with Mitsubishi UFJ Securities, its CDM consultant, began in 2005, and the consulting agreement signed in 2006. The local consultant, Klima, started to work with the company in preparing the PAD since 2005. The PDD was submitted to the Philippines DNA in early 2007. The sole reason for delaying the validation was to wait for the result of the host country DNA approval. The Philippine DNA approval was issued through the Letter of Approval in July 2007[7].

B.6. Emission reductions

B.6.1. Explanation of methodological choices

The emission reduction (ER_y) of the project activity in a given year *y* is estimated in line with ACM0002, as follows.

(Equation 1)

$$ER_y = BE_y - \left(PE_y + L_y\right)$$

which is the difference between the baseline emissions (BE_y) and the sum of the project emissions (PE_y) and leakage (L_y).

Baseline Emissions

The baseline emissions in year *y* (BE_y) are given as:

(Equation 2)

$$BE_y = EG_y \cdot EF_y$$

where:

EG_y = Electricity supplied to the grid by the Project in year *y* (MWh);

EF_y = Emission factor for grid electricity for year *y* (tCO_2/MWh).

[7] *Letter of Approval issued by DENR-EMB, www.cdmdna.emb.gov.ph*

The grid emission factor, EF_y, is calculated as the Combined Margin emission factor, which is the weighted average of the Operating Margin emission factor and the Build Margin emission factor, as follows.

(Equation 3)

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

where:

w_{OM} = Weight of Operating Margin in the Combined Margin (fraction), 0.5 by default;

w_{BM} = Weight of Build Margin in the Combined Margin (fraction), 0.5 by default;

$EF_{OM,y}$ = Emission factor of set of plants in the Operating Margin in year *y* (tCO_2/MWh);

$EF_{BM,y}$ = Emission factor of set of plants in the Build Margin in year *y* (tCO_2/MWh).

For the Operating Margin, ACM0002 allows four methods: (a) Simple OM, (b) Simple Adjusted OM, (c) Dispatch Data Analysis OM, or (d) Average OM. The first methodological choice, Dispatch Data Analysis OM, was not carried out due to data constraints, namely the lack of (i) the grid system dispatch order of operation for each power plant of the system, and (ii) the amount of power that is dispatched from all plants in the system during each hour. The Simple OM is not suitable for the Mindanao grid the low-cost/must-run resources constitute more than 50% of the total grid generation. Therefore, the Simple Adjusted OM is applied.

The Simple Adjusted OM ($EF_{OM,simple\_adjusted,y}$) is calculated according to the following formula:

(Equation 4)

$$EF_{OM,simple\_adjusted,y} = (1-\lambda_y) \cdot \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}} + \lambda_y \cdot \frac{\sum_{i,k} F_{i,k,y} \cdot COEF_{i,k}}{\sum_{k} GEN_{k,y}}$$

where:

λ_y = Fraction of time during which low-cost/must-run resources are on the margin in year *y* (fraction);

$F_{i,j,y}$ = Amount of fuel consumed by relevant power sources *j* in year *y*, where *j* refers to the power sources in the grid excluding low-cost/must-run power plants and including any imports to the grid;

$F_{i,k,y}$ = Amount of fuel consumed by relevant power sources *k* in year *y*, where *k* refers to the low-cost/must-run power sources in the grid;

$COEF_{i,j}$ = CO_2 emission coefficient of fuel *i* used in power sources *j* (tCO_2/mass or volume unit);

$COEF_{i,k}$ = CO_2 emission coefficient of fuel *i* used in power sources *k* (tCO_2/mass or volume unit);

$GEN_{j,y}$ = Electricity supplied to the grid by source *j* (MWh).

$GEN_{k,y}$ = Electricity supplied to the grid by source *k* (MWh).

The Build Margin is calculated as the generation-weighted average emission factor of a sample of power plants *m*, as follows.

(Equation 5)

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

where

$F_{i,m,y}$ = Amount of fuel consumed by sample group *m* in year *y*, where sample group *m* consists of either the five power plants that have been built most recently, or the power plant

capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently;

$COEF_{i,m}$ = CO_2 emission coefficient of fuel *i* used in sample group *m* (tCO_2/mass or volume unit);

$GEN_{m,y}$ = Electricity supplied to the grid by sample group *m* (MWh).

Both the Operating Margin and Build Margin emission factors will be monitored and determined *ex post*.

Project Emissions

According to ACM0002, project emissions may have risen for hydro power projects with new reservoirs. The Project is run-of-the-river type that does not require a reservoir. It only has small head ponds for the purpose of regulating daily output. The size of these head ponds are such that no project emissions need to be accounted for, as shown in the following table.

Table 5: Power density of the Sibulan plants

Plant	Installed Capacity (MW)	Head Pond Surface Area (m^2)	Power Density (W/m^2)
Plant A	16.5	13,751	1,200
Plant B	26	14,140	1,839
Total	42.5	27,891	1,524

The power density of the Project is well over $10W/m^2$. Therefore, there are no associated project emissions.,

Leakage

ACM0002 stipulates that neither positive nor negative leakage in relation to activities such as power plant construction, fuel handling and land inundation are not to be accounted for. No leakage is associated with the Project.

As there are no project emissions or leakage, the emission reduction equation is reduced to:

(Equation 6)

$$ER_y = BE_y$$

B.6.2. Data and parameters fixed ex ante

Data / Parameter	Surface area at full reservoir level
Unit	m^2
Description	Surface area of the reservoir / head pond to show the level of project emissions
Source of data	HSI
Value(s) applied	27,891 m^2 (Plant A = 13,751 m^2, Plant B = 14,140 m^2)
Choice of data or Measurement methods and procedures	The construction of the head pond will be carried out based on the project designs. Therefore, the most accurate source of data is from the project participants' final project designs.
Purpose of data	Calculation of project emissions
Additional comment	N/A

B.6.3. Ex ante calculation of emission reductions

Baseline emission

The *ex ante* estimation of baseline emissions due to grid electricity displacement is provided below.

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

As explained in Section B.6.1., the Simple Adjusted OM approach is selected. The Simple Adjusted OM will be monitored *ex post*. For the purpose of an *ex ante* approximation, grid data from 2004[8] will be used as input data into (Equation 4).

Firstly, λ_y, which shows the fraction of time during which low-cost/must-run resources are marginal in a year, is calculated following Steps (i) to (iv).

Step (i) Plot a Load Duration Curve

The hourly system load data is collected and sorted from highest to lowest MW level. This is then plotted against 8784[9] hours in the year, in descending order.

Table 6: Extract of hourly system load for Mindanao grid in 2004

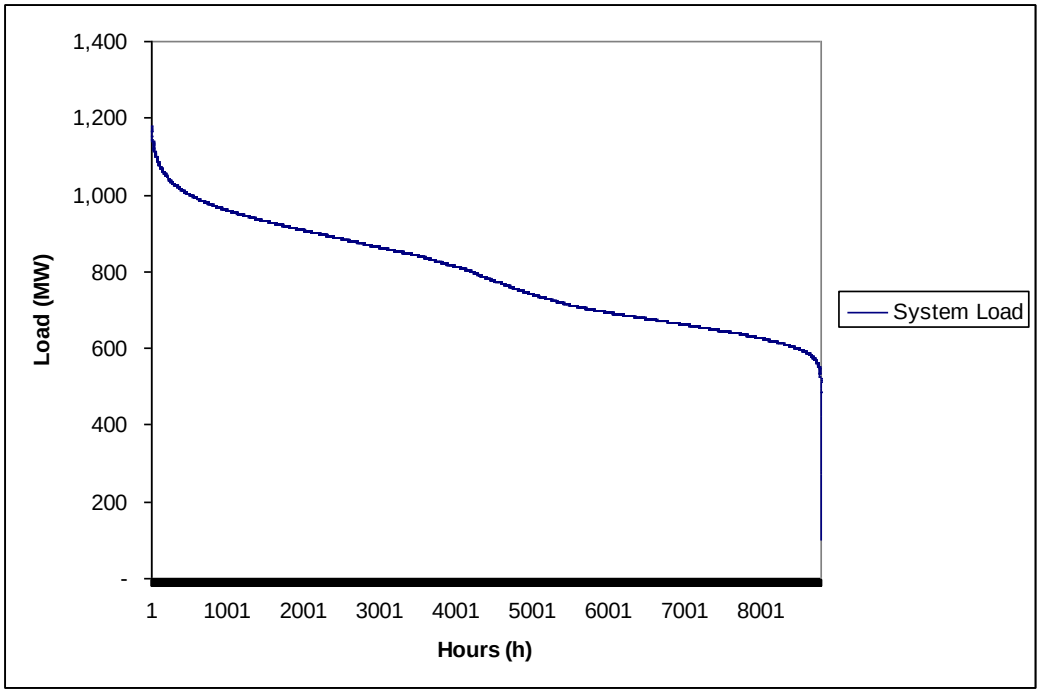
Ranking	Date (mm/dd/yyyy)	Time (hh:mm)	System Load (MW)
1	12/17/2004	19:00	1,177.30
2	12/16/2004	18:00	1,175.69
3	12/16/2004	19:00	1,171.89
4	12/15/2004	18:00	1,167.99
5	12/17/2004	18:00	1,164.03
8630	2/28/2004	7:00	584.70
8631	2/16/2004	3:00	584.50
8632	11/28/2004	7:00	584.30
8633	12/26/2004	5:00	584.26
8634	7/26/2004	2:00	584.20
8682	4/29/2004	13	276.70
8683	12/13/2004	17	270.78
8684	12/13/2004	16	95.40

The load duration curve is then plotted.

[8] *While 2005 system load data is available, corresponding fuel consumption data is not. Therefore, 2004 data is used for the purpose of the ex ante estimation.*

[9] *366 days in 2004.*

Figure 5: Load Duration Curve (1) for Mindanao grid in 2004



Step (ii) Organize data by generating sources

The annual generation from low-cost/must-run resources ($\sum_k GEN_{k,y}$) is deduced from the following grid data.

Table 7: Annual power generation for Mindanao grid in 2004[10]

Plant type	Plant	Annual Power Generation (MWh)
Hydro	Agus1	50,658
	Agus2	747,438
	Agus4	783,555
	Agus5	327,157
	Agus6	1,152,349
	Agus7	262,797
	Agusan	6,825
	Pulangi 4	880,980
	Talomo 2, 2A, 2B, 3	9,699
	Sub-total Hydro	*4,221,458*
Geothermal	Mt. Apo I	463,296
	Mt. Apo II	448,262
	Sub-total Geothermal	911,559
Oil	NMPC1	38,112
	NMPC2	104,605
	PB117	576,891
	PB118	579,010
	SPPC - Gen. Santos	239,578

[10] *National Power Corporation*

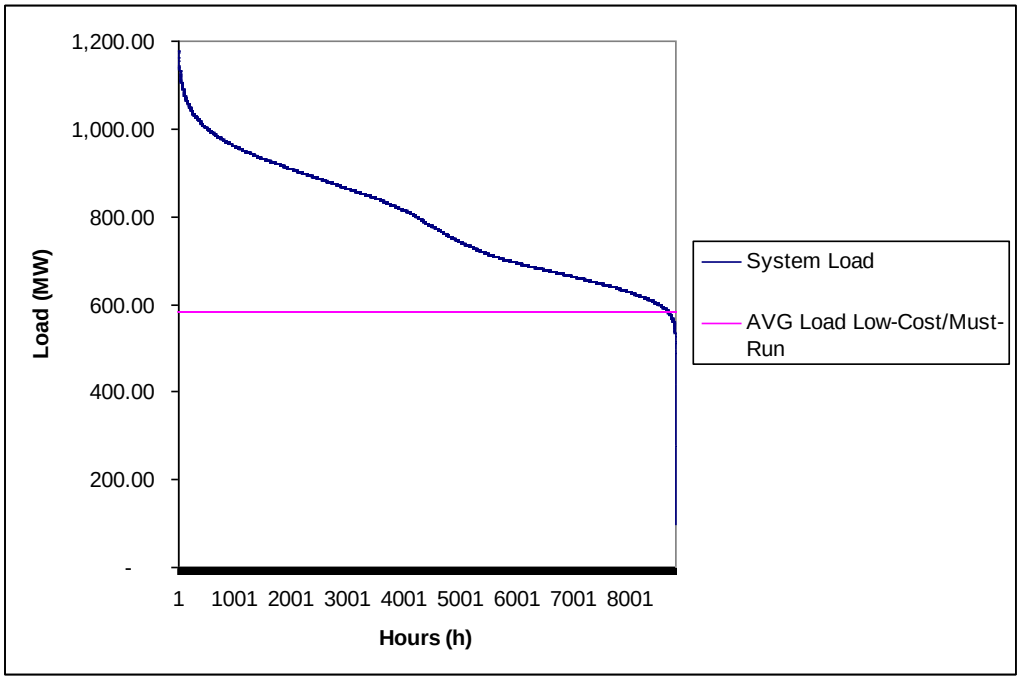
	WMPC - Zamboanga	308,687
	Sub-total Diesel	1,846,883
Total Grid		6,979,899
Total Low-Cost/Must-Run		5,133,016

Consistent with ACM0002, hydro and geothermal power sources were deemed to be low-cost/must-run resources. Generation from these plants totalled 5,133,016 MWh.

Step (iii) Fill Load Duration Curve

The average load (in MW) from low-cost/must-run resources in a year is calculated by dividing the total generation from low-cost/must-run resources, determined in Step (ii) as 5,133,016 MWh, by 8,784 hours of the year. This gives an average load of 584.36 MW.

Figure 6: Load Duration Curve (2) for Mindanao grid in 2004



Step (iv) Determine the number of hours per year for which low-cost/must-run sources are on the margin.

The fraction of time during which low-cost/must-run resources are marginal is the number of hours to the right of the intersection of the two lines in 4. As the lines intersect at the 8,611th hour, the low-cost/must-run resources are considered to be marginal for 173 hours (8,784 hours – 8,611 hours) of the year. This is divided by the total number of hours in the year to obtain λ_y, which is 0.02.

The next step is to calculate the Simple Adjusted OM emission factor using (Equation 4. As the power sources *k* – low-cost/must-run plants – consist of hydro and geothermal resources, emission from this source is considered zero. Therefore, (Equation 4 can be simplified to the following.

(Equation 7)

$$EF_{OM,simple\_adjusted,y} = (1-\lambda_y) \cdot \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

Due to data availability constraints, 2004 NPC statistics for fossil fuel consumption ($\sum_{i,j} F_{i,j,y}$) and total generation from power sources *j* ($\sum_{j} GEN_{j,y}$) are used.

Table 8: 2004 statistics for fossil fuel fired plants in Mindanao grid[11]

Plant Name	Generation (MWh)	Fuel Consumption	
		Bunker (L)	Diesel (L)
NMPC1	38,112	8,910,351	318,486
NMPC2	104,605	24,509,119	417,751
PB117	576,891	119,532,231	67,917
PB118	579,010	117,861,760	184,376
SPPC - Gen. Santos	239,578	54,549,931	58,572
WMPC - Zamboanga	308,687	59,525,800	71,517
Total	1,846,883	384,889,192	1,118,619

The above data is used in conjunction with the below IPCC values.

Table 9: IPCC and other input values

Parameters		Bunker (Residual) Oil	Diesel Oil	Unit	Source
Input Values	CO_2 emission factor	77,400	74,100	$kgCO_2/TJ$	IPCC 2006 Table 2.2, Volume 2
	NCV	43	46	TJ/Gg=TJ/kt	PDOE
	Density	0.94	0.84	kg/l	PDOE
Result	Fuel Consumption in tons by j sources (Fi,j,y)	327,156	996	t fuel	Calculated
	CO2EFi,j	3	3	tCO_2/t fuel	Calculated
	ΣFi,j,y x COEFi,j/ΣGENj,y	0.661		tCO_2/MWh	Calculated

The weighted average emission is therefore 0.661 tCO_2 / MWh. Adjusting for λ_y = 0.02 the Simple Adjusted OM emission factor is:

$EF_{OM,simple\_adjusted,y}$ = (1-0.02) x 0.661 tCO_2/MWh
= 0.648 tCO_2/MWh

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

[11] *www.napocor.gov.ph*

The Build Margin is calculated as the generation-weighted average emission factor of a sample of power plants *m*, using (Equation 5). ACM0002 stipulates that the sample group *m* be comprised of either the five (5) power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

In terms of the data vintage, the data required for the determination of the Build Margin emission factor will be monitored *ex post* (Option 2 of ACM0002). For the purpose of the PDD, most recent data available at the time of PDD production is used for an ex ante estimation of the emission factor. As can be seen in Table 10, the five newest plants represent 21.6% of the total grid power generation, exceeding 20%.

Table 10: Build Margin power plants[12]

Plant Name	Date Commissioned	Generation (MWh)	Fuel Consumption	
			Bunker (L)	Diesel (L)
NMPC1	2004	38,112	8,910,351	318,486
Mount Apo Geo II	1999	448,262	N/A	N/A
SPPC - Gen. Santos	1998	239,578	54,549,931	58,572
Talomo HE Plant 2	1998	454	N/A	N/A
Talomo HE Plant 2A	1998	425	N/A	N/A
Talomo HE Plant 2B	1998	362	N/A	N/A
Talomo HE Plant 3	1998	8,458	N/A	N/A
WMPC - Zamboanga	1997	308,687	59,525,800	71,517
Mount Apo Geo I	1996	463,296	N/A	N/A
Total Generation		1,507,635	122,986,082	448,575
% Total Grid Generation		21.6%		

The CO_2 emission factor for the Build Margin is calculated in the same manner as the Operating Margin, using the figures below.

Table 11: BM CO_2 emission factor

Parameters		Bunker (Residual) Oil	Diesel Oil	Unit	Source
Input Values	CO2 emission factor	77,400	74,100	kgCO2/TJ	IPCC 2006 Table 2.2, Volume 2
	NCV	43	46	TJ/Gg=TJ/kt	PDOE
	Density	0.94	0.84	kg/l	PDOE
Result	Fuel Consumption in	104,538		t fuel	Calculated
	tonnes by j sources (Fi,j,y)		399		
	CO2EFi,m	3	3	tCO2/t fuel	Calculated
	ΣFi,m,y xCOEFi,m/ΣGENm,y		0.259	tCO2/MWh	Calculated

The Build Margin emission factor is therefore 0.259 tCO_2 / MWh.

Step 3. Calculate the baseline emission factor (EF_y)

[12] *www.napocor.gov.ph*

The baseline emission factor is calculated as the Combined Margin, which is the weighted average of the Operating Margin and Build Margin emission factors, as given in (Equation 3. Default weightings of 50% each are used.

The simple average of 0.648 tCO_2 / MWh and 0.259 tCO_2/MWh is 0.454tCO_2 / MWh. The baseline emission factor is therefore 0.454 tCO_2 / MWh.

Step 4. Calculate baseline emissions

The baseline emission is calculated by multiplying the electricity supplied by the Project to the grid with the baseline grid emission factor (Equation 2).

The Sibulan plants are expected to supply 209,635 MWh of electricity to the Mindanao grid each year, at full operation.

Therefore,

Total baseline emissions for full year operation = 209,635 MWh x 0.454 tCO_2/MWh
= 95,174 tCO_2

Emission reductions

As explained in Section B.6.1., the emission reduction is equivalent to the baseline emission.

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

The estimated emission reductions for all years of the crediting period are summarized in the table below.

Table 12: Ex ante emission reduction estimations for first 7-year crediting period (in tCO2)

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2009 (50%)	42,175	0	0	42,715
2010	95,174	0	0	95,174
2011	95,174	0	0	95,174
2012	95,174	0	0	95,174
2013	95,174	0	0	95,174
2014	95,174	0	0	95,174
2015	95,174	0	0	95,174
2016 (50%)	52,810	0	0	52,810
Total	666,219	0	0	666,219
Total number of crediting years	7			
Annual average over the crediting period	95,174	0	0	95,174

B.7. Monitoring plan

All data to be monitored for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of CERs for the project activity, whichever occurs later.

B.7.1. Data and parameters to be monitored

Data / Parameter	EG_y
Unit	MWh
Description	Electricity supplied to the grid by the Project
Source of data	Hedcor Sibulan, Inc.
Value(s) applied	209,635
Measurement methods and procedures	Measured by electricity meter
Monitoring frequency	Electricity supplied will be monitored continuously and recorded monthly.
QA/QC procedures	The measured amount will be double checked against sales receipts. Meters will be test or calibrated by the meter owner, NGCP, based on their calibration practice.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	EF_y
Unit	tCO_2/MWh
Description	CO_2 emission factor of the grid
Source of data	Calculated by project participants
Value(s) applied	0.454
Measurement methods and procedures	Calculated as a weighted sum of the OM and BM emission factors.
Monitoring frequency	Annually
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$EF_{OM,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of set of plants in the Operating Margin
Source of data	Calculated by project participants
Value(s) applied	0.648
Measurement methods and procedures	Calculated using the Simple Adjusted OM method.
Monitoring frequency	Annually

QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$EF_{BM,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of set of plants in the Build Margin
Source of data	Calculated by project participants
Value(s) applied	0.259
Measurement methods and procedures	Calculated for recently built power plants as defined in ACM0002.
Monitoring frequency	Annually
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$F_{i,y}$
Unit	Mass or volume
Description	Amount of fuel consumed type i consumed by each power source / plant
Source of data	PDOE and/or NPC
Value(s) applied	Total bunker oil = 384,889,192 litres Total diesel oil = 1,118,619 litres For details, please refer to Table 8
Measurement methods and procedures	-
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$COEF_i$
Unit	tCO_2/ mass or volume unit
Description	CO_2 emission coefficient of each fuel type *i*
Source of data	Project-specific, country-specific or IPCC default values
Value(s) applied	Bunker oil = 3.35 tCO_2/t fuel Diesel oil = 3.39 tCO_2/t fuel Based on IPCC default CO_2 emission factors and Philippines fuel data.

Measurement methods and procedures	-
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$GEN_{j/k/n,y}$
Unit	MWh
Description	Electricity generation of each power source / plant *j*, *k* or *n*
Source of data	PDOE and/or NPC
Value(s) applied	$GEN_{j,y}$ = 1,846,883 MWh $GEN_{k,y}$ = 5,133,016 MWh
Measurement methods and procedures	-
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	Plant name (OM)
Unit	Text
Description	Power source / plant for constituting the Operating Margin
Source of data	PDOE and/or NPC[13]

[13] *www.doe.gov.ph*

Value(s) applied	Type *j* plants: NMPC1 NMPC2 PB117 PB118 SPPC - Gen. Santos WMPC - Zamboanga Type *k* plants: Agus 1 Agus 2 Agus 4 Agus 5 Agus 6 Agus 7 Agusan Pulangui 4 Talomo HE Plant 2 Talomo HE Plant 2A Talomo HE Plant 2B Talomo HE Plant 3 Mount Apo Geo I Mount Apo Geo II
Measurement methods and procedures	Identified according to method stipulated in ACM0002.
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as official public data will be used. The official data will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	Plant name (BM)
Unit	Text
Description	Power source / plant for constituting the Build Margin
Source of data	PDOE and/or NPC[14]
Value(s) applied	NMPC1 Mount Apo Geo II SPPC - Gen. Santos Talomo HE Plant 2 Talomo HE Plant 2A Talomo HE Plant 2B Talomo HE Plant 3 WMPC - Zamboanga Mount Apo Geo I
Measurement methods and procedures	Identified according to method stipulated in ACM0002.
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as official public data will be used. The official data will be made fully available for verification.

[14] *www.doe.gov.ph*

Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	λ_y
Unit	Fraction
Description	Fraction of time during which low-cost/must-run resources are on the margin
Source of data	PDOE and/or NPC
Value(s) applied	0.02
Measurement methods and procedures	The λ value is calculated using data from PDOE and/or NPC, using the method outlined in ACM0002.
Monitoring frequency	Annually
QA/QC procedures	No QA/QC procedures required, as this value is calculated. The basis of the calculations will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$GEN_{j/k/l,y\_IMPORTS}$
Unit	MWh
Description	Electricity imports to the project electricity system
Source of data	PDOE and/or NPC
Value(s) applied	0
Measurement methods and procedures	-
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as official public data will be used. The official data will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$COEF_{i,j,y\_IMPORTS}$
Unit	tCO_2/mass or volume unit
Description	CO_2 emission coefficient of fuels used in connected electricity system (if imports occur)
Source of data	PDOE and/or NPC
Value(s) applied	N/A (no imports)
Measurement methods and procedures	-
Monitoring frequency	This will be monitored annually.
QA/QC procedures	No QA/QC procedures required, as official public data will be used. The official data will be made fully available for verification.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

B.7.2. Sampling plan

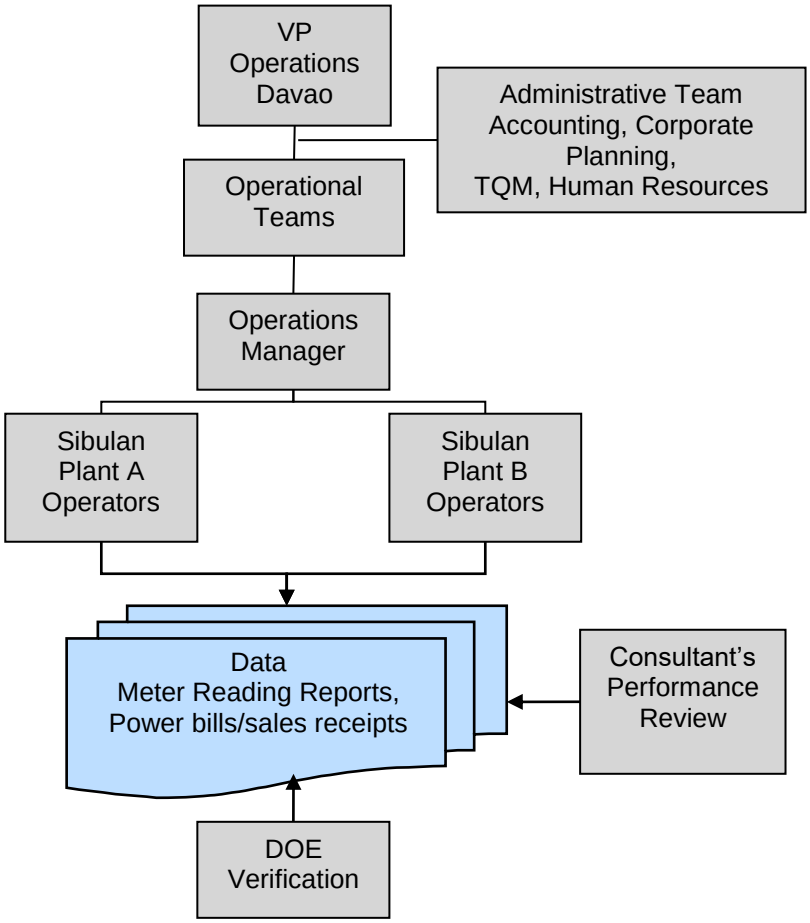
N/A

B.7.3. Other elements of monitoring plan

1. Operational and management structure

The figure below outlines the operational and management structure that HSI will implement for the monitoring of data listed in B.7.1. An operational and administrative team will be established for monitoring and reporting. This team composes of a Vice President of Operations, an Operations Manager as well as a group of engineers, operators, technicians and administrative staff.

Figure 7: Operational and management structure for monitoring activity



The monitoring of the data to be used in computing for the CER will be conducted the plants engineers under the supervision of the Operations Manager. All data will be recorded in accordance with the procedures and will be stored electronically in a systematic, transparent and traceable manner.

The Operational and Administrative Teams will review the data archived and submit a complete set of documentation, which indicates the calculation procedure as well as the ex-post emission reduction estimate to the Corporate Planning Department for internal verification on a monthly basis. This documentation will also be verified externally by an independent Designated

Operational Entity (DOE) on an annual basis. The DOE would issue a verification report based on its findings and submit it to the CDM Executive Board for the issuance of CERs.

An internal training will also be conducted for the plant engineers and technicians to ensure that data monitoring and archiving tasks will be implemented properly and according to the procedures and requirements as set in the monitoring plan.

By the time of the plant commissioning, a specific monitoring plan will be developed.

2. Temporary metering arrangement

At present, a temporary metering arrangement is in place due to the need of the grid operator, DLPC, to connect other substations through HSI's 69kV line (the line between the Project plant and Puan Switching Station, where the revenue meters are located) due to various reasons such as supplying the power requirement of the commissioning works of a grid-connected coal power plant in the vicinity, transformer issues and rehabilitation works at other substations not related to the Project itself. This arrangement has been in place since 2014, and is expected to continue through to June 2017. It is noted that the exact timing is subject to change depending on the changing grid circumstances. However, it remains a fact that under either the temporary or permanent metering arrangement, the project will retain the same level of accuracy, and the method of invoicing and the approval of the invoicing by DLPC will be the same.

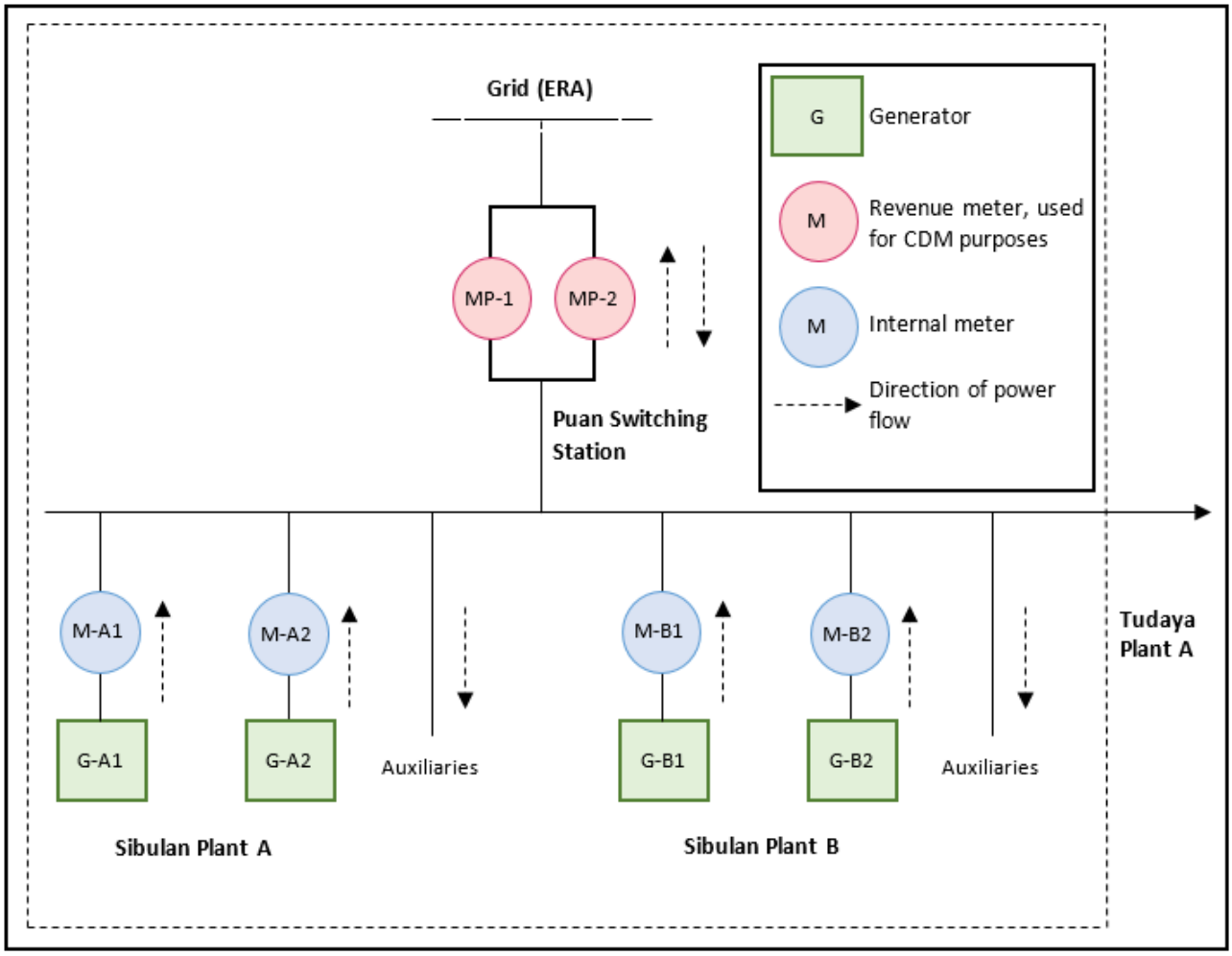


Figure 8: Permanent metering arrangement

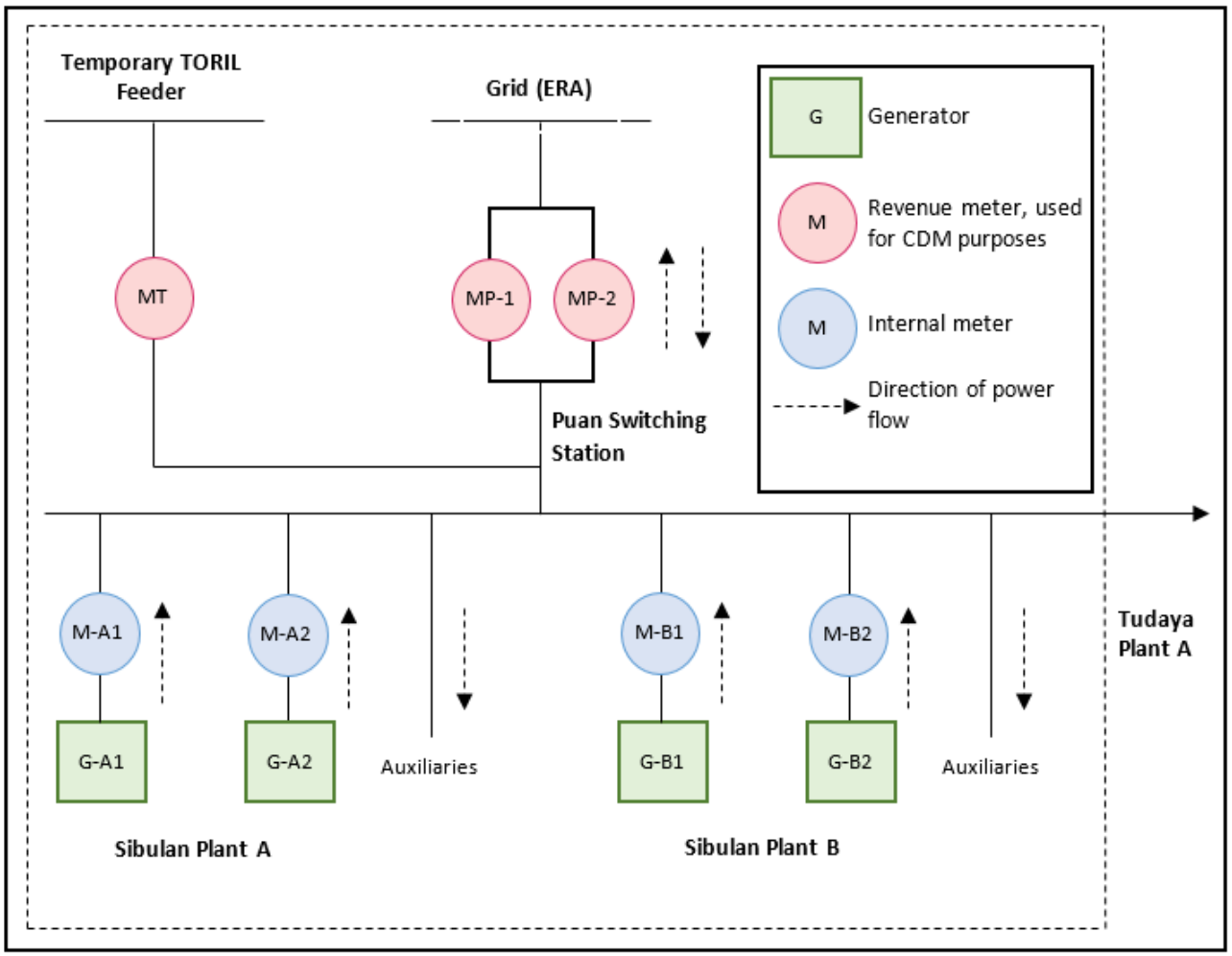


Figure 9: Temporary metering arrangement

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

Date of completion of the application of the baseline study and monitoring methodology
16/08/2007

Entity responsible for the application of the baseline and monitoring methodology to the Project activity:

Clean Energy Finance Committee
Mitsubishi UFJ Securities Co., Ltd
26/F Marunouchi Building
2-4-1 Marunouchi, Chiyoda-ku
Tokyo 100-6317, Japan
Tel: +81-3-6213-6236
Fax: +81-3-6213-6175
Email: hatano-junji@sc.mufg.jp; ktochikawa@cefconsulting.com
Mitsubishi UFJ Securities is not a project participant listed in Annex 1.

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

30/10/2005

The starting date of the project activity is defined as the date on which Hedcor accepted Klima's proposal to initiate CDM work.

C.1.2. Expected operational lifetime of project activity

25 years

C.2. Crediting period of project activity

C.2.1. Type of crediting period

Table 13: Renewable Crediting Period of the Project

Crediting period	Duration		
	Length (No. of years)	Start (Year)	End (Year)
■ Renewable Periods			
First Period	7	2009	2015
Second Period	7	2016	2022
Third Period	7	2023	2029
□ Fixed Period			

C.2.2. Start date of crediting period

01/08/2009

The starting date of the first crediting period is defined as the expected date of start of commercial operation.

C.2.3. Length of crediting period

7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

The Project is a run-of-river type hydro power project, therefore environmental impacts typically associated with hydro power plants such as construction of dams, inundation of large areas, and change in waterways do not occur. A study of potential impacts was carried out in the form of an Environmental Impact Statement (EIS) for the Sibulan Plants as mandated by Presidential Decree No. 1586 and Proclamation No. 2146. The EIS concluded that environmental impacts were low for most environmental parameters. The results are summarized below.

Table 14: Summary of environmental impacts of the Project

Environmental Parameters	Project Phase			
	Pre-Construction	Construction	Operation and Maintenance	Abandonment
Geology/Soils/Geotechnical Aspects	Low	Medium	Low	Negligible
Surface Hydrology	Negligible	Medium	Medium	Negligible
Water Quality	Negligible	Medium	Negligible	Negligible
Ambient Air Quality and Noise	Negligible	Medium	Negligible	Negligible
Terrestrial Vegetation	Negligible	Medium	Negligible	Negligible
Terrestrial Wildlife	Negligible	Medium	Negligible	Negligible
Freshwater Aquatic Biota	Negligible	Low	Low	Negligible
Solid Wastes	Negligible	High	Medium	Negligible
Public Health and Safety	Negligible	Medium	Low	Negligible

The above impacts are analysed, and, where necessary, mitigating measures are specified in the EIS. The project participants will implement an Environmental Management Program for the Project, not only to comply with government regulations, and keeping with the company's environmental policy, but to comply with the MOAs signed with the communities. This program includes a Social Development Plan, which will provide the appropriate social measures to compensate for any disruptions or disturbances that may result from the implementation of the Project. The Environmental Management Program and Social Development Plan were submitted to the DOE during the validation site visit.

D.2. Environmental impact assessment

In accordance with Presidential Decree No. 1586 and Proclamation No. 2146, which considers the Project as an Environmentally Critical Project, an Environmental Impact Statement was prepared for the Sibulan Plants in October 2005. The EIS was duly submitted to the Department of Environment and Natural Resources, which issued an Environmental Compliance Certificate (ECC 11-06-03-03-033-4220) on March 15, 2006. The ECC signifies that the Project has given due consideration to the environmental impacts, as well as mitigation of such effects. The Environmental Compliance Certificate was submitted to the DOE during the validation site visit.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

Relative to the implementation of the Project, it is necessary to go through a rigorous stakeholder process. The stakeholder process needed for the Project involves not only the communities surrounding the Project but also the indigenous cultural communities in the area and the National Commission on Indigenous Peoples (NCIP). Furthermore, the Indigenous Peoples Reform Act (IPRA) mandates a Free and Prior Informed Consent (FPIC) from local tribal leaders. To obtain the FPIC however, it is necessary to coordinate with the NCIP for all stakeholder consultations. The minutes of the consultative meetings held in connection with the Project were provided to the DOE during the validation site visit, for all seven sessions as described in Table 16.

The series of stakeholder meetings listed in the table below began with a preliminary consultative meeting with the local leaders and the NCIP. The objectives of the HSI were laid out and a consensus was reached. This consensus was echoed to other communities through community assemblies. On May 26, 2005 a memorandum of agreement (MOA) was drafted between the proponent, NCIP, and the tribal communities of Sibulan. The memorandum of agreement was signed on June 15, 2005 finalizing the agreements among the parties involved. The Certificate of Free and Prior Informed Consent (FPIC) and the Memorandum of Agreement (MOA) were provided to the DOE during the validation site visit.

Table 15: Summary of stakeholder meetings for the Sibulan Plants

Date	Venue	Agenda	Attendees
March 4, 2005	Kapatagan, Digos City	Preliminary Consultative Meeting	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain / tribal leader, elders) - EMB Region 11 - Department of Energy - Maunsell Philippines
April 14, 2005	Lower Pogpog, Sibulan, Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Matanao Service Center - Hedcor, Inc.
April 23, 2005	Sibulan, Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Tribal Council of Sibulan - Matanao Service Center - Hedcor, Inc.
May 26, 2005	A&B Hotel, Digos City	Drafting of Memorandum of Agreement (MOA)	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder)

			- Hedcor, Inc.
June 06, 2005	Sibulan Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members of Bagobo and Tagabawa (Including chieftain, elder) - Hedcor, Inc.
June 10, 2005	Lower Pogpog, Sibulan Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Hedcor, Inc.
June 11, 2005	Sibulan Sta. Cruz, Davao del Sur	Signing of Memorandum of Agreement	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members of Bagobo and Tagabawa (Including chieftain, elder) - Hedcor, Inc.

The perception survey made during the environmental impact assessment stage of the Project showed that it had a high rating for its social acceptability. One hundred fifty three (153) people from the areas that are to be affected were surveyed and the results showed that 79% of them support the Project in varying degrees (mild to strong).

The results of the consultative meetings which were held with the different stakeholders are embodied in a Memorandum of Agreement between the IPs, the NCIP and the proponent. The main concerns of the stakeholders that were addressed by the MOA include employment opportunities, maintaining the adequate flow of water in the project area, the provision of other socio-economic benefits, and their participation in the Project implementation.

The Memorandum of Agreement between the IPs, the NCIP and the Proponent is a proof that due account was taken of all the comments received during the consultative meetings. The drafting and the finalization of the MOA were done through community assemblies to assure transparency.

The said MOA identifies the different roles and responsibilities of the proponent, the IPs and the NCIP as well as the different conditions and agreements that were agreed upon during the FPIC process. The following documents were provided to the DOE during the validation site visit:

- the Documentation of Stakeholders' Consultation with corresponding minutes of the meetings
- the Memorandum of Agreement between the IPs and other local government entities,
- the Philippine Government Certificates given by different government offices as proof for the Projects compliance
- the Sustainable Development Benefits Description where discussions for stakeholder benefits are presented.

E.2. Summary of comments received

In the course of the consultation meetings done with the stakeholders, several concerns were raised given that the Project is situated within the jurisdiction of Pogpog, Tudaya, and the Sibulan Proper. The main issues raised during the consultation meetings were:

- Possible impacts on Tudaya Falls, a place of worship for some sections of the indigenous community.
- Possible impacts in the tubing area as far as water diversion is concerned.
- Compensation for the Indigenous People.
- Livelihood and employment opportunities for local residents.

Excerpts from the minutes are provided in the table below, categorized as concerns from the stakeholders and answers from the proponent:

Table 16: Summary of Stakeholder Comments

Issues and Concerns	Meeting Where Issue was Raised	Proponent's Response	Resulting Agreement
"It is planned that the Sibulan Project will divert 90% of the flowing water and the remaining 10% will continue to flow towards the Tudaya Falls. What will be the effect of the 10% flow to the Tudaya Falls?"	Main agenda of the meetings	The diverted water will pass through the Plant's system for energy conversion, after which the water will flow back to the river towards Tudaya Falls.	The activity is embedded in the Project's operation and agreed upon thru a Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005. (Section 3.11)
"Sibulan River is declared by the Sangguniang Bayan of Sta. Cruz as a 'protected river'. If the Project will push through, will Hedcor conduct an inventory of their roadway and how many trees will be cut off?"	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005	The land survey has been completed in coordination with PAMB. The plan is to construct a road from upper Tudaya to Lower Tudaya.	Special Land Use Permit No. XI-2007-01 dated April 4, 2007. The construction of the access road has been formalized in the Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005. (Section 3.6)
"We would like to ask Hedcor to conduct another meeting with the indirectly affected areas such as Barangay Darong."	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005	A separate meeting was done with Barangay Darong. The output of the meeting was formalized with a memorandum of agreement (MOA).	Memorandum of Agreement between Hedcor Sibulan, Inc. and Barangay Darong was signed on July 18, 2006.
"What is the exact number of employment opportunities for the IPs?"	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005 Community Assembly at Lower Pogpog, Sibulan dated April 14, 2005 Community Assembly at Sibulan dated June 6, 2005	Initially, an estimate of 700-800 during construction.	This agreement has been formalized in the Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005. (Section 3.12). Further, the construction contract between Hedcor Sibulan Inc. and its contractor, JVACC stipulates preference for indigenous labor in the contract, section 6.1.1
"What is the impact as the Project operates to the flow of water in the river, particularly in the tubing area?"	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005 Community Assembly at Lower Pogpog,	Water tubing starts 1km down from Plant B. At that point, the water will have been diverted back to the river thus, Plants A and B will not affect the tubing area.	This is the existing layout for the Project, carried over during construction and extends during the operation period.

	Sibulan dated April 14, 2005		
"The Local Government Unit of Sta. Cruz has a tourism plan for Tudaya Falls. They are requesting Hedcor to present the Project to the Municipality of Sta. Cruz and the Municipal Tourism Council."	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005	A separate meeting was made with the Department of Tourism.	Certification from the Department of Tourism dated September 7, 2005. It indicates that the Department has no objection to the Project.
"Exact process of consultation is very important to avoid possible discontentment, disagreement, and violation of the primary rights of the IPs. Proper community consultation is recommended. Is this activity conducted also in Barangay Sibulan?"	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005	A separate meeting was done with Barangay Sibulan. The output of the meeting was formalized with a memorandum of agreement (MOA).	Memorandum of Agreement between Hedcor Sibulan, Inc. and Barangay Sibulan was signed on July 18, 2006.
"The municipality of Sta. Cruz has existing guidelines for watershed management and development. We are recommending that the comparison between Hedcor's watershed management program and that of the municipality should be studied further."	Preliminary Consultative Meeting at Kapatagan, Digos City dated March 4, 2005	Hedcor will be working with the watershed management program of the municipality, and will provide financial assistance to start the program.	Formalized in the Memorandum of Agreement between Hedcor Inc. and the Municipality of Sta. Cruz dated March 2006. (Section I.A.22) where in HSI shall undertake the reforestation of the affected areas in accordance with the comprehensive development plan of the Sta. Cruz municipality and its Watershed Management Program. Further, an annual budget is allocated in the watershed management projects.
"The Php0.005/kWhr fund that will be provided by Hedcor to the IPs is not enough to compensate the risks of constructing the plants."	Drafting of MOA at A&B Hotel, Digos City dated May 26, 2005	One percent (1%) of the gross output will be reflected in the Memorandum of Agreement. As per computation, the Php0.005 share of the IPs will reach an amount of about Php1.5M per year.	In the Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005, it stipulated that HSI will grant P0.01/kwh of electricity sales to the Bagobo-Tagabawa Tribe (IPs) and increasing at P0.005/kwh every five years. This translates to approximately Php2.11M on HSI first year of operation.
"There is a need to specify in the MOA that IPs from Tudaya can only benefit from the Php0.005/kWhr share since there are other IPs from other places."	Community Assembly at Lower Pogpog, Sibulan dated April 14, 2005 Drafting of MOA at A&B Hotel, Digos City dated May 26, 2005 Community Assembly	It will be specified in the MOA. Together with this, the tribal community will be organized into a cooperative registered under SEC and NCIP to manage annual funds given by Hedcor.	In the Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005, it stipulated that HSI will grant P0.01/kwh of electricity sales to the Bagobo-Tagabawa Tribe (IPs) and increasing at P0.005/kwh every five years. This translates to approximately Php2.11M on

	at Sibulan dated June 6, 2005		HSI first year of operation.
"The barangay officials changes everytime there is an election, we suggest that the share of Tudaya and Sibulan should be separated. We are given the right to self governance thus, the share of IPs in Tudaya should be placed in the name of IPs of Tudaya and separated from Sibulan."	Drafting of MOA at A&B Hotel, Digos City dated May 26, 2005 Community Assembly at Sibulan dated June 6, 2005	Separate MOAs will be made for the IPs and Barangay Sibulan.	The Memorandum of Agreement between Hedcor, NCIP, and the IPs was signed on June 11, 2005. The share/benefits shall be paid to the IPs mentioned in the MOA. Two separate MOAs were signed between HSI and Barangay Darong; and HSI and Barangay Sibulan. It stipulated in the MOA that the payments shall be made to the incumbent treasurers of the barangays.
"It was observed by the council of elders of Tudaya that the proponent does not coordinate with them. At present, supplies and materials of the proponent were brought in Tudaya. It should be that before the start of the work, coordination should be done not to surprise the populace."	Drafting of MOA at A&B Hotel, Digos City dated May 26, 2005	All activities are now coordinated with the council of elders and LGUs as evidenced in the minutes of meeting and several public consultations.	In the MOA between Hedcor; NCIP and the Indigenous Community of the Bagobo-Tagabawa Tribes (IPs); the IPs were represented through their Council of Elders.
"What are the benefits that will be given to the community?"	Community Assembly at Lower Pogpog, Sibulan dated April 14, 2005 Drafting of MOA at A&B Hotel, Digos City dated May 26, 2005 Community Assembly at Sibulan dated June 6, 2005 Community Assembly at Lower Pogpog, Sibulan dated June 10, 2005	The following will be done for the benefit of the stakeholders: Construction of roads Employment opportunities Scholarship programs Energization Access to potable water IP shares from project revenue	The benefits to the affected communities were formalized in the Memorandum of Agreement between Hedcor, NCIP, and the IPs dated June 11, 2005. (Section 3.5 to 3.15); MOA between Hedcor Inc. and Barangay Sibulan dated July 18, 2006. (Section 5); MOA between Hedcor Inc. and Barangay Darong dated July 18, 2006

Taking into account all the comments received, the overall support for the Project from all project-affected communities was strong.

E.3. Report on consideration of comments received

The comments received as well as the requests made by the stakeholders were duly noted, solidifying the agreement through the provision of a Memorandum of Agreement not only with the Indigenous People but also with the various Local Government units surrounding the Project area. Listed below are the certificates and Memorandum of Agreements:

- Certificate of Free, Prior and Informed Consent, issued 11 June, 2005
- MOA between Hedcor, NCIP, and the Indigenous Peoples
- MOA between Hedcor Sibulan, Inc. and Barangay Darong
- MOA between Hedcor Sibulan, Inc. and the Municipality of Sta. Cruz
- MOA between Hedcor Sibulan, Inc. and the Province of Davao del Sur
- Endorsement Letter from the Protected Areas Management Board
- Certification from the Department of Tourism
- Certificate of Water Availability from the National Water Resources Board
- Environmental Compliance Certificate from the Environmental Management Bureau
- Compliance Certificate from the National Commission on Indigenous Peoples

These Memorandum of Agreement and Certificates prove that due account was taken of the stakeholder concerns. These also present the formality in providing the benefits that are intended for the stakeholders.

SECTION F. Approval and authorization

The letter of approval (LoA) from the host country was obtained on the 25 May 2007. The letters of approval has been submitted before the request for registration the PDD.

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

The below information for Hedcor Sibulan Inc. represents the Project Participant information relevant to both the Philippines and UK DNA approvals.

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Hedcor Sibulan, Inc.
Street/P.O. Box	1 Ladislawa, Ladislawa Avenue, Buhangin
Building	
City	Davao City
State/Region	Region 11
Postcode	8000
Country	Republic of the Philippines
Telephone	+63 82 222 4839
Fax	+63 82 221 5346
E-mail	inquiry@hedcor.com
Website	http://www.hedcor.com
Contact person	Luis Miguel Aboitiz / Aboitiz Equity Ventures
Title	First Vice President
Salutation	Mr.
Last name	Aboitiz
Middle name	Osmena
First name	Luis Miguel
Department	
Mobile	
Direct fax	+63 2 817 3560
Direct tel.	+63 2 793 2800
Personal e-mail	miguel_aboitiz@aboitiz.com

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Klinkenberg Traders B.V.
Street/P.O. Box	Beursplein 5
Building	
City	Amsterdam
State/Region	
Postcode	1012 JW
Country	Netherlands
Telephone	+31 20 5782054
Fax	+31 20 5782054
E-mail	info@ktraders.nl
Website	www.ktraders.nl

Contact person	Adrianus Klinkenberg
Title	
Salutation	Mr.
Last name	Klinkenberg
Middle name	
First name	Adrianus
Department	
Mobile	
Direct fax	+31 20 5782054
Direct tel.	+31 20 5782054
Personal e-mail	

Appendix 2. Affirmation regarding public funding

No public funding is involved.

Appendix 3. Applicability of methodology and standardized baseline

Please refer to Sections B.2 for details.

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

The following information was used for the *ex ante* emission reduction estimation

Table: Extract of hourly system load for Mindanao grid in 2004[15]

Ranking	Date (mm/dd/yyyy)	Time (hh:mm)	System Load (MW)
1	12/17/2004	19:00	1,177.30
2	12/16/2004	18:00	1,175.69
3	12/16/2004	19:00	1,171.89
4	12/15/2004	18:00	1,167.99
5	12/17/2004	18:00	1,164.03
8630	2/28/2004	7:00	584.70
8631	2/16/2004	3:00	584.50
8632	11/28/2004	7:00	584.30
8633	12/26/2004	5:00	584.26
8634	7/26/2004	2:00	584.20
8682	4/29/2004	13	276.70
8683	12/13/2004	17	270.78
8684	12/13/2004	16	95.40

Table: Annual power generation for Mindanao grid in 2004[16]

Plant type	Plant	Annual Power Generation (MWh)
Hydro	Agus1	50,658
	Agus2	747,438
	Agus4	783,555
	Agus5	327,157
	Agus6	1,152,349
	Agus7	262,797
	Agusan	6,825
	Pulangi 4	880,980
	Talomo 2, 2A, 2B, 3	9,699
	Sub-total Hydro	*4,221,458*
Geothermal	Mt. Apo I	463,296
	Mt. Apo II	448,262
	Sub-total Geothermal	911,559
Oil	NMPC1	38,112
	NMPC2	104,605
	PB117	576,891
	PB118	579,010
	SPPC - Gen. Santos	239,578

[15] *Source: National Power Corporation*

[16] *Source:*

	WMPC - Zamboanga	308,687
	Sub-total Diesel	1,846,883
Total Grid		6,979,899
Total Low-Cost/Must-Run		5,133,016

Table: 2004 statistics for fossil fuel fired plants in Mindanao grid[17]

Plant Name	Generation (MWh)	Fuel Consumption	
		Bunker (L)	Diesel (L)
NMPC1	38,112	8,910,351	318,486
NMPC2	104,605	24,509,119	417,751
PB117	576,891	119,532,231	67,917
PB118	579,010	117,861,760	184,376
SPPC - Gen. Santos	239,578	54,549,931	58,572
WMPC - Zamboanga	308,687	59,525,800	71,517
Total	1,846,883	384,889,192	1,118,619

Table: IPCC and other input values

Parameters		Bunker (Residual) Oil	Diesel Oil	Unit	Source
Input Values	CO_2 emission factor	77,400	74,100	kgCO2/TJ	IPCC 2006 Table 2.2, Volume 2
	NCV	43	46	TJ/Gg=TJ/kt	PDOE
	Density	0.94	0.84	kg/l	PDOE

Table: Build Margin power plants

Plant Name	Date Commissioned	Generation (MWh)	Fuel Consumption	
			Bunker (L)	Diesel (L)
NMPC1	2004	38,112	8,910,351	318,486
Mount Apo Geo II	1999	448,262	N/A	N/A
SPPC - Gen. Santos	1998	239,578	54,549,931	58,572
Talomo HE Plant 2	1998	454	N/A	N/A
Talomo HE Plant 2A	1998	425	N/A	N/A
Talomo HE Plant 2B	1998	362	N/A	N/A
Talomo HE Plant 3	1998	8,458	N/A	N/A
WMPC - Zamboanga	1997	308,687	59,525,800	71,517
Mount Apo Geo I	1996	463,296	N/A	N/A
Total Generation		1,507,635	122,986,082	448,575
% Total Grid Generation		21.6%		

[17] *Source: National Power Corporation*

Appendix 5. Further background information on monitoring plan

Please refer to Sections B.7.1, B.7.2 and B.7.3 for details.

Appendix 6. Summary of post registration changes

The following permanent change has been made in this revised PDD:

Permanent change from the registered monitoring plan, monitoring methodology or standardized baseline.

PDD Version 3: The calibration frequency of electricity meter has been updated as it is not within the control of the project participant. The meter testing and calibration is carried out by meter owner as per their practice.

PDD Version 4: The monitoring plan was revised to include the temporary meter arrangement where an additional revenue meter has been employed at a different location to the original substation, at the request of the grid company.

In the course of this revision prompted by the change of monitoring plan, two types of incidental changes were also introduced:

(a) Reflecting the latest project information that was already previously approved without need for revision of PDD at the time, namely Section A.4. and Appendix 1 relating to the project participants' information.

(b) Some changes required to meet the requirements of the differing CDM-PDD-FORM, such as the listing of installed technologies in Section A.3.

Appendix 7. Financial Indicators

INPUT PARAMETERS:

Base case

Parameter	Value Sibulan	Unit	Note
Project Life	25	years	
Generating Capacity	42.5	MW	
Generation Full Year Year 1 Year 26	 209,635 92,897 116,322	MWh	
Electricity Tariff	4.0856	PHP/kWh	Bid Price, assumed increase at 2% annually
Capital Cost	5,121,000,000	PHP	Drawn over 2 years
O&M Cost Full Year Year 1 Year 26	 326,622,507 136,092,711 190,529,796	PHP/year	
Corporate Tax Tax Rate Tax Holiday	 0.32 6	 fraction years	

Sensitivity Analysis 1: Increase net plant utilization factor by 5%

Parameter	Value Sibulan	Unit	Note
Project Life	25	years	
Generating Capacity	42.5	MW	
Generation Full Year Year 1 Year 26	 220,117 97,542 122,138	MWh	Base case MWh generation increased by 5%
Electricity Tariff	4.0856	PHP/kWh	
Capital Cost	5,121,000,000	PHP	Drawn over 2 years
O&M Cost Full Year Year 1 Year 26	 326,622,507 136,092,711 190,529,796	PHP/year	
Corporate Tax			
Tax Rate Tax Holiday	0.32 6	fraction years	

Sensitivity Analysis 2: Decrease capital cost by 5%

Parameter	Value	Unit	Note

	Sibulan		
Project Life	25	years	
Generating Capacity	42.5	MW	
Generation Full Year Year 1 Year 26	 209,635 92,897 116,322	MWh	
Electricity Tariff	4.0856	PHP/kWh	
Capital Cost	4,864,950,000	PHP	Base case Capital Cost decreased by 5%. Drawn over 2 years
O&M Cost Full Year Year 1 Year 26	 326,622,507 136,092,711 190,529,796	PHP/year	
Corporate Tax Tax Rate Tax Holiday	 0.32 6	 fraction years	

Sensitivity Analysis 3: Decrease O&M cost by 10%

Parameter	Value	Unit	Note
	Sibulan		
Project Life	25	years	
Generating Capacity	42.5	MW	
Generation Full Year Year 1 Year 26	 209,635 92,897 116,322	MWh	
Electricity Tariff	4.0856	PHP/kWh	
Capital Cost	5,121,000,000	PHP	Drawn over 2 years
O&M Cost Full Year Year 1 Year 26	 293,960,256 122,483,440 171,476,816	PHP/year	Base case O&M decreased by 10%
Corporate Tax Tax Rate Tax Holiday	 0.32 6	 fraction years	

Sensitivity Analysis 4: Electricity tariff increased by 5%

Parameter	Value	Unit	Note
	Sibulan		
Project Life	25	years	
Generating Capacity	42.5	MW	
Generation Full Year Year 1 Year 26	 209,635 92,897 116,322	MWh	
Electricity Tariff	4.2899	PHP/kWh	Base case tariff increased by 5%
Capital Cost	5,121,000,000	PHP	Drawn over 2 years
O&M Cost Full Year Year 1 Year 26	 326,622,507 136,092,711 190,529,796	PHP/year	
Corporate Tax Tax Rate Tax Holiday	 0.32 6	 fraction years	

Appendix 8. Discussion on Project Structures

General Overview

The Project to be undertaken by HSI as the project company, is a cascade development of two power plants; namely, an upstream Sibulan Plant A with an installed capacity of 16.5 MW and a downstream Sibulan Plant B with an installed capacity of 26MW . The combined average annual energy is estimated to be 209,635 MWh. The Plants are essentially of the run-of-river types that include an intake weir, short tunnel, surface pipeline, desander, headpond, high pressure surface penstock, surface power plant, substation, switchyard, and transmission line. The Plants will each house two Pelton turbines and generating units suitable for local and remote control.

The purpose of the project activity is to generate carbon neutral electricity using the water resources of the Sibulan River, which will be exported to the Mindanao grid. In doing so, the Project will displace fossil fuel-fired power generation of the said grid, contributing to a reduction of greenhouse gases (GHGs). Once the Project is fully operational, it is expected to contribute to emission reductions of approximately 81,129 tCO_2 annually.

Geotechnical Assessment

Detailed geological investigation with an override of geotechnical mapping showed a significant change in the geomorphology and rock mass characteristics in the geologic setting for Plant A compared to that of Plant B, although they are all of the same pyroclastic or volcanic rock from Mt. Apo. For simplicity and engineering purposes, the rock units are described as Andesite overlying conformably to the agglomerate. The massive to highly broken andesite is of considerable thickness over 50 meters at the upper section of the project area (@ el. +1000m ASL), thinning out to an entirely eroded and/or weathered characteristic towards the lower section (@ el. +500m ASL). The agglomerate is generally massive over 100-meter thick which could either be matrix or clast-supported on well indurated volcanic breccia at the upper section, thinning out and becoming less indurated at the lower section (@ el. -500m ASL). These volcanic rocks are all flat to moderately inclined to the east.

The rock units at the Power House A bear the steep to vertical NNE conjugated Columnar/Cooling joints and with NNW/NE flat beddings. The rock units starting at Weir B downwards have the NW/SW moderate to steep joints with flat to undulating SW and NE flow beddings of NW strike. The marked contrast in the textural and structural features downwards were also reflected in the topographic changes whereby the former is characterized by very steep to vertical constricted gorges, while the latter is on steep to moderate to flat land forms with water plateau ridges.

In view of these marked differences in geotechnical properties and topographic settings, the water conveyance appropriate for the sections from Weir A at the Baroring River to the Forebay A location at Tudaya and the section from Weir B located downstream of the Baroring and Sibulan Rivers confluence to the Bidaran Creek is a full-face tunnel. The rest of the water conveyance will be of steel circular pipe laid above ground at desired elevation and gradient

Tunnel Water Conveyance

The rock mass that will be traversed by the tunnel from Baroring River to the Tudaya Forebay A is mostly agglomerate and the rest on andesite. In terms of rock quality, the agglomerate is classified as very good rock while the andesite reflected a scaled down rating from good to fair rock.

Both classifications are generally favorable for tunnel excavation with light to moderate tunnel support requirement recommended for this rock mass strength. The ground water required in this section is generally on dry to damp/wet ground with isolated minor flow encounter.

The tunnel from Weir B to the Bidaran Creek will all be in agglomerate of intercalated volcanic tuff-breccia. Rock mass quality assessment indicated a range from good to fair to poor rock strength. However, only 35 percent of the total length of the tunnel will traverse this type of rock mass. Ground water regime is generally wet over the fair to poor rock section closer to the Bidaran Creek becoming dryer towards the Tomari Creek and to the Weir B location at the Sibulan River. The rock mass classification in this section generally is likewise favorable for underground excavation.

Pipeline Water Conveyance

The natural slopes that will carry the pipeline water conveyance from the Bidaran to the Baracatan area will generally support a competent ground.

Natural slope configuration of the time-tested ground slopes from 20 to 30 degrees for soil and 45 to 60 degrees for rock are sound basis for the engineering design for the excavation and support requirements, along the Pipe Conveyance alignment. The natural slopes in the area reflect both hard-rock structure-controlled and soil-mass ground instabilities with the preponderance of the former to the latter.

The rest of the infrastructures will be over the andesite and agglomerate rock masses. Except for the closely-spaced Cooling/tension joints observed in the andesite, and the inferred moderately fractured rock mass, all geological discontinuities are widely spaced over 5 to 10 meters particularly on the Clast-supported agglomerate or volcanic breccia. All the rock types except at near surface where weathering can take place are hard and brittle with unconfined compressive strength of 100 MPa. On the other hand, weathering can be considered fresh to slightly weathered along the joints/fractures at depth. At the surface, in-situ weathering is no more than 3 meters deep grading from soil to moderately weathered rock except for the old talus/remobilized materials, the soil horizon is considered as uniformly to poorly graded salty clay.

Plant A

a.) Intake Weirs

The Sibulan weir will be located in a gorge with moderate side slopes. It will be a concrete structure about 4.61 m. high founded on strong, hard conglomerate rock after removal of about 2 m depth of river alluvium. The weir will contain a crest type intake to capture flows up to the design flows of 2.675 m^3/sec. Flows greater than the design flow will pass over the weir and continue downstream. The intake will be covered with steel screens to prevent ingress of stones greater than 16mm in diameter. Stones which pass through the screens will be caught in a rock trap at the entrance to the conveyance pipe and discharged back to the river. Visual evidence indicates that the rivers in this area carry significantly less sediment load than those in Benguet and Ilocos Sur provinces, the sites of Hedcor, Inc.'s Luzon Plants.

The weir will be equipped with a by-pass sluice to enable the conveyance to be dewatered if necessary and also to make releases past the weir to maintain the attraction of Tudaya falls.

The Baroring weir will be constructed in a narrow steep-sided gorge by means of a cableway from the access road at the top of the gorge. The design will be essentially similar to that of Sibulan weir with crest intake, rock trap and by-pass facility.

b.)Conveyance Structures

The water conveyance for Plant A will comprise of a low-pressure tunnel and a steel pipeline. The Baroring conveyance will be a tunnel with a horse-shoe shaped cross section. The finished dimension is 2.1 m wide and 2.5 m high. The tunnel will be excavated using the conventional “drill and blast” method through andesite and agglomerate rock types. Geotechnical assessment has indicated that tunnel excavations will run through generally good ground condition for about 65% of the length of the tunnel. The balance will be in fair to poor ground. Permanent support will comprise rock bolts and Steel Fiber Reinforced Shotcrete (SFRS), throughout the tunnel length with progressively more robust dimensions as poorer rocks are encountered. The tunnel dimensions have been dictated by the smallest tunnel cross section that can be economically constructed and are somewhat larger than is required hydraulically.

The Sibulan conveyance will be a steel pipeline of 1.09 m diameter, laid on a bench cut into the valley side. The pipe will be laid above the ground where rock is encountered and buried where possible to reduce visual impact. The pipeline will consist of individual pipes welded in position. Where laid above ground, it will be supported on concrete sleepers with expansion provisions as necessary. The pipe will be coated internally and externally to prevent corrosion.

c.) Desander and Headpond

The desander is a twin channel, settling- basin type constructed of concrete. The basin will settle out sediment particles that have passed through the rock trap. Deposited sediment will be cleared from the desander through flushing sluice when excess water is available.

The Headpond is formed by an embankment up to 15 m high located in a broad but short valley. The surface area of the pond will be 1.5 ha. and a capacity of 70,000 m^3. The embankment will be formed using spoil from the Baroring tunnel excavation. Due to the inadequate impermeability of the natural soil in the headpond area, the pond area and upstream face of the embankment will be covered by a butyl rubber sheet laid on a 100 mm thick blanket of sand. The headpond will be provided with a spillway to prevent overtopping of the embankment under the most unfavorable conditions. Water flow into the penstock will be controlled by a radial gate.

d.) Penstock

The penstock will consist of a welded steel pipe laid below ground where soil is deep enough and laid on concrete sleepers above ground where rock is close to surface. The mean diameter of the 2.90 km. long penstock will be 1.27 m. The first 2.60 km will follow the gently sloping ridge between the Baroring and Sibulan Rivers before descending the steep valley side and crossing the Sibulan River on a pipe bridge to the powerhouse. Adequate concrete thrust blocks will be constructed at significant changes in pipeline direction.

e.) Power Plant

The powerhouse will be a surface structure located at the left bank of the Baroring River. It will rest on an alluvial bar comprising material ranging in size from boulders to gravel. It will have an area of 563 m^2 and with the main floor located 1.5 m above the expected 1000-

year return period flood. The substructure and tailrace will be of concrete, and the superstructure will consists of sheet steel on a sheet frame.

The powerhouse will contain two (2) horizontal-shaft twin–jet pelton turbines, with the runners overhung from the generator shafts. The rated capacity of each unit will be 8MW under a net head of 365.60 m. the design flow on each unit is 2.64 m^3/sec. The turbines will be fitted with jet deflectors so that load can be rejected quickly in the event of a forced outage without causing significant water hammer pressure in the penstock. The generator voltage will be 13.8 kV which will be stepped up to 138 kV through two (2) transformers in a switchyard located on the ridge above the powerhouse. A transmission line 23 km long will evacuate power to DLPC's ERA main sub station where the output will be measured.

Plant B

a.) Diversion Weir

A concrete diversion weir will be constructed across the Baroring River on a rock foundation about 50.0 m downstream from Plant A powerhouse. The weir will have a crest type intake with a screen to prevent ingress of stones larger than 16 mm. Stones smaller than 16 mm will be collected in a rock trap and periodically flushed back to the river.

About half of the water flows for Plant B will have passed through Plant A and will be virtually sediment free. This water will be conveyed in a short pipe directly to the conveyance tunnel in order to avoid the water being contaminated with sediment as it would be if it were returned to the river and diverted again by the weir.

b.) Conveyance Structures

The first 1.2 km of the conveyance line from the weir to Bidaran Creek will consists of a horse-shoe shaped tunnel of minimum dimensions. From the geological and geotechnical investigations, 65% of the tunnel length will be in good rock and the balance in fair to poor rock conditions. Permanent supports will consist of SFRS for the whole length with the robustness of the support increasing with reducing rock quality. Light steel ribs maybe required in the weakest rock that will be encountered. The tunnel will hit daylight in Tomari Creek which is approximately at the midpoint of the tunnel and can be used as a second face for tunnel driving. There are only limited sites to dump tunnel spoil but adequate space has been identified.

From the tunnel portal at Bidaran Creek, the conveyance will be a low pressure welded steel pipe laid on concrete sleepers above ground on a bench cut along the valley side which slopes generally at approximately 45 degrees at this elevation and location. At a distance of 0.60 km downstream of Bidaran Creek, the pipe will emerge from the valley side onto the gently sloping ridge for a further 1.10 km. This section will be buried where ground conditions permit

c.) Headpond and Desander

The headpond will be located on the undulating ground between the deep valleys of the Baracatan and Sibulan Rivers. An embankment running parallel with the Sibulan River will form an elongated headpond 302 m long by an average of 71 m wide and 12 m high. A desander will be provided at the upstream end of the pond provided with a radial gate to control the water flow from the entrance to the penstock. The surface area of the pond will be 2.17 ha. with a capacity of 50,000 m^3. The headpond will be lined with a butyl rubber sheet to prevent leakage. The pond is provided with a concrete spillway structure discharging to the Sibulan River.

d.) Penstock

The penstock will consist of a welded steel pipe below ground where soil is deep enough and laid on concrete sleepers above ground where rock is close to the surface. The mean diameter of the 4.52 km long penstock will be 1.67 m. From the headpond, the penstock will cross the Baracatan River as an inverted siphon and follow the existing road down a gentle, uniform grade for 1.0 km before descending the steep Sibulan valley side to the powerhouse site. Adequate concrete thrust blocks will be provided at significant changes in pipeline direction.

e.) Power Plant

The powerhouse will be a surface structure located on the left bank of the Sibulan River. It will rest on an alluvial bar comprising materials ranging from boulders to gravel. It will have a plan area of 23m by 25m and with the main floor located 1.5m above the expected 1000-year return period flood. The sub-structure and tailrace will be of concrete and the superstructure will consist of sheet steel on a steel frame. The powerhouse will contain two (2) horizontal shaft twin-jet pelton turbines, with the runners overhung from the generator shafts. The rated capacity of each unit will be 13MW under a net head of 301.00m. The design flow on each unit is 5.05 m^3/sec. The turbines will be fitted with jet deflectors so that load can be rejected quickly in the event of a forced outage without causing significant water hammer pressure in the penstock. The generator voltage will be 13.8kv which will be stepped up to 138 kV through two (2) transformers in a switchyard located on the ridge above the powerhouse. A transmission line 23 km long will evacuate power to DLPC's ERA main sub station where the output will be measured.

Appendix 9. Discussion on Hydrology

The proposed project sites are within the provincial boundaries of Davao del Sur, located between two mountain peaks that form the catchments area of the Sibulan River. These are Mt. Apo towering 2938-masl and Mt. Sibulan at an elevation of 1522 masl. The drainage system of the proposed hydropower development has steep slopes and a high gradient.

1. Climate

The Philippine climate was classified according to Corona's classification, which only considers rainfall as gauge. This consists of four types:

Type I - Two pronounced seasons; dry from November to April, wet the rest of the year.

Type II - No dry season with pronounced; relatively dry from November to April and wet fro the rest of the year.

Type III - Season not very pronounced; relatively dry from November to April and wet for the rest of the year

Type IV - Rainfall more or less evenly distributed throughout the year.

The project area is located within the boundary of Davao City and Davao Del Sur which falls under Type IV.

2. Regional Hydrological Measurements of Rainfall and River Flow

Rainfall data relevant to the project area were obtained from the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) and from the Department of Agriculture where several private agriculture companies submit rainfall records. There are quite a number of rainfall stations in the area. The readings from these stations were used to derive the isohyetal map of the project area as basis to determine the Annual Average Rainfall (AAR) of the catchments of the proposed intakes. Table 01 below shows the average annual rainfall of plant A and B catchments:

Table 1- Plant A and B catchment's Average Annual Rainfall

Catchment	Catchment Area	Average Annual Rainfall
Plant A	72.32 km^2	2310 mm
Plant B	127.66 km^2	2270 mm

PAGASA Station located at Sasa, Davao City has the longest record from 1961 to present. The Astorga Station located at Sibulan, Sta. Cruz, Davao Del Sur is nearest to the site with record from 1997 to present, this station is at elevation 120masl while the intakes are located at elevation 498masl to 900masl. There are several gauging stations in the region including the river basin at which the proposed hydropower plants are located. This reduces the hydrological risk of the Project considering that these flow records could be used to estimate the river flows at the proposed intakes.

Hedcor installed two gauging stations at the intakes of Plant A particularly along the Baroring and the Sibulan River. The gauging stations were installed on May 19, 2004.

Other important data and information gathered were the climate maps of PAGASA, topographic maps from the NAMRIA, Land Use Maps from the Department of Environment and Natural Resources and reports from private organizations like the Davao City Water District.

3. Sibulan Catchments

The catchments of the Project are within the Sibulan River Basin. It is located between two mountain peaks that form the catchments area of the Sibulan River. These are Mt. Apo towering 2938-masl and Mt. Sibulan with an elevation of 1522masl. The drainage system of the Project has steep slopes and a high gradient.

The Sibulan River is gauged at the Cebulan Gauging Station with a drainage area of 171 km^2. It is approximately 20.2 km and 15.3 km downstream from the proposed Plant A and Plant B intakes respectively.

Plant A taps Baroring River with a drainage area of 36.02 km^2 and Sibulan River with a drainage area of 36.30 km^2. Plant B taps the Sibulan River, approximately 50 m downstream from the junction of Baroring and Sibulan River and this has a drainage area of 100.23 km^2. Along the headrace of Plant B, Tomari Creek with a drainage area of 8.00 km^2 and Baracatan Creek with a drainage area of 10.76 km^2 were tapped.

As mentioned in the previous section, two gauging stations were established within the catchments and are located at the proposed locations of the intakes for Plant A, namely; Sibulan Intake and Baroring Intake. Downstream of the Sibulan Intake is the Tudaya Falls which was one of the considerations of the water assessment. Flows were proposed to be controlled at the Sibulan Intake to allow an agreed amount of flow not to be diverted but to let it flow towards the Tudaya Falls.

4. Data Analysis

Review and analysis of the data and information were undertaken to establish its reliability and validity. Standard data quality checks include calculating the mean, maximum, minimum and five-year mean. Trends and inconsistencies in the data were detected through visual examination of the plots of the data.

The methodology used to calculate for water availability at the proposed intakes depended on the available record of flow observation at the Cebulan Gauging Station that is located within the river basin of the Project. The gauging station was established and being observed by the Bureau of Research and Standards of the Department of Public Works and Highways. It has records since 1956 to 1977 and 1986 until present. The recorded flow of 1956 to 1977 was taken at the station with drainage area of 128 km^2 while the record of 1986 to present was taken at the station with drainage area of 171 km^2. Both records of the Cebulan Gauging Stations were checked for completeness, trends and inconsistencies. The record of 1956 to 1977 was observed to have 12 years of complete annual data and that the plot was examined to have a significant number of inconsistencies. Thus, the data were disregarded as reference. In addition there are 12 years of records from an older gauge located a few kilometers upstream of the current gauge of which 5 years have very few gaps. These years of older record were used to check the unit runoff calculated from the more recent records. The 19 years of flow records from Cebulan gauge are based on three readings per day of the water level at an easily accessible staff gauge near to the national highway bridge. There are very few gaps in the record.

The 19 years of flow records were compared with other gauge records in the region and found to be very consistent in terms of the shape on the unitized flow duration curves, and hence increased the confidence that there are no serious errors in the flow records. It was expected that the flows could be verified by correlating them with rainfall records from other gauges in

the area. However, the correlations were remarkably weak. This could be explained by either many or all of the records being unreliable, or that rainfall occurs as somewhat isolated events, rather than as frontal systems giving uniform rain over large areas at the same time. However, the Hedcor team measured flows twice per day at both sites of Plant A intakes for the period May 2003 to April 2004, and a very low correlation was obtained between these very reliable records. If similar rain occurred over both catchments at the same time, then the measurements would be highly correlated.

Non uniform rainfall within a relatively small area covered by the gauging network is possible, since Sibulan and adjacent catchments lie on the slopes of three volcanoes with elevations up to over 3,000 m. Rain gauges in the area are located at elevations from near sea level up to over 900 m. A strong trend of increasing rainfall with elevation was detected. This relationship was used in conjunction with the contour map of the area to draw isohyetal lines over the catchment where there were no rainfall records.

Cebulan gauge is located at 39 m above sea level with a catchment area of 171 km2 whereas the intake for Plant B is at El. 500 m and has a catchment area of 99 km2, while the weirs for plant A have catchments of about 36 km2 each, and are located at El 900 m. A rain gauge near the Cebulan stream gauge, has recorded an average depth of rainfall over 5 years of 2,000 mm per year. It is estimated that at Plant A intakes, rainfall is about 3,000 mm per year, and considerably higher towards the catchment boundary.

The measurements at the intake weirs showed much higher unit runoff at the higher elevations as predicted by the rainfall data. However, since only a single year of flows at the intakes was available with concurrent flows at the Cebulan gauge, it was decided to take a rather conservative increase in unit runoff at the higher elevations as compared to the measured flow at Cebulan gauge. 19 years of flow data at the intakes was compiled and used to optimize the project components and calculate power and energy benefits.

The peak flow for each of the 19 years of record at Cebulan gauge were used as a first estimate for assessing flood peaks. However, since the mean daily flow from these small catchments could be significantly less than the instantaneous peak flow (hence maximum flood level), the alternative "Unit Hydrograph" method was employed. This utilized the hourly rainfall measured over a 20-year period at a gauge in Davao city by PAGASA. Storm intensities with different return periods were available and were applied to the catchments. Using the catchment physical characteristics, flood hydrographs corresponding to various return periods were derived and used to design the various structures. The weirs were designed to resist the 200-year return period floods. The Plants were also set above the 200-year flood level, with an additional flood wall up to the level of the 1,000-year return period flood.

In addition, the flow-duration–curve (FDC) at the gauge was compared to other rivers in the region and found to be similar in shape, which indicates that there are no serious consistent errors in the flow records. The study team also installed its own flow gauges very close to the sites of the two intakes of Plant A, from which records are available from May 2004 to April 2005. Inspection of rainfall gauges in nearby catchments shows that rainfall in the upper Sibulan catchment could exceed 3,000mm/year, and would explain why the unit run-off (m^3/sec/km^2) is much higher at the intakes than at the long-term gauge. Nevertheless, the estimated long-term flow at the intakes has been conservatively adjusted upwards from the long term flows recorded at the gauge.

5. Assessment of Flow at the Proposed Intakes

The assessment of water availability at the proposed intakes utilized the flow observations recorded at the Cebulan Gauging Station from 1986 to 2004, (19 years of record). The objective of the evaluation is to transpose the observed flows at the Cebulan Gauging Station to the intakes of Plant A and Plant B.

With an available river flow station along the Sibulan River located at the Cebulan Bridge, approximately 20.2 km and 15.3 km downstream from Plant A and Plant B respectively, the Analogue Method Using the Observed Flows was adopted where the flow observations were transposed to the location of the proposed intakes from the gauged station through the ratio of the drainage areas and the derived specific discharges. This method was used considering that the gauged flow represents in general the characteristics of the catchment covering the area from the point where the flow observations were taken to the proposed intakes of Plant A and B.

The Analogue Method then proceeded by transposing the observed flows from 1986 extending it until 2004 of the Cebulan Gauging Station to the intake locations of the proposed plants. The flow at the intakes is then calculated from the ratio of the specific discharge and the ratio of the drainage area.

$$Q_{intake} = Q_{gauge} \times \frac{DA_{intake}}{DA_{gauge}} \times \frac{q_{intake}}{q_{gauge}}$$

where:

Q_{intake} - discharge at intake
Q_{gauge} - discharge at gauge
DA_{intake} - drainage area at intake
q_{intake} - specific discharge at intake
DA_{gauge} - drainage area at gauge
q_{gauge} - specific discharge at gauge

The specific discharge at the intakes were taken from the derived correlation equation between the Cebulan Gauging Station by BRS-DPWH and the established gauging station of Hedcor located at the proposed intakes at Baroring and Sibulan River. The recorded flow of Hedcor simultaneous to the records of BRS-DPWH provided the equation. Higher unit flow per drainage area was computed at the intake catchments located upstream of the river based on the observed simultaneous records of BRS-DPWH and Hedcor. The land cover encompassing further downstream until the location of the gauging station show percentages of cultivated lands and build up areas. The table below shows the computed unit discharges of the catchments:

Table 02 – Catchment Unit Discharges

	ACTUAL RECORD (May-January)		
	Ave. runoff	**Drainage Area (Km^2)**	**Ave. runoff / Drainage Area**
Sibulan River (Weir A1)	2.2505	36.295	0.062005
Baroring River (Weir A2)	2.1189	36.019	0.058826
Sibulan River (171 km^2)	8.3108	171.000	0.048601
Sibulan River (128 km^2)	6.5691	128.000	0.051321
Sibulan River (Weir B)		100.226	
Sibulan River (Weir A)		72.314	

The method produced 19 years of transposed flows to the intakes that could be used to simulate the generation of the proposed plants. The transposed flows at the intakes of Plant A and Plant B were used to derive the flow duration curve for both plants.

With a design flow of 5.11 for Plant A, the flow is available 25% of the time and for a design flow of 9.31 for Plant B, the flow is available 32% of the time. This suggests that the flow being considered is available along the river for power generation.

A compensation flow of 100 lps is considered for environmental concerns. In addition to this, the Sibulan Weir for Plant A is regulated to allow a flow of 1.61 cm to pass the weir for 8 hrs during day time for the month of January until April. HSI is not aware of any previous evaluation of the hydrology of the Sibulan River basin. However it was fortunate to have 19 years of good quality, daily flow records from a site close to the mouth of Sibulan River, collected and published by BRS-DPWH. Factors contributing to the high quality of the records are:

a. At the gauging site, the river bed consists of in-situ rock, so that river cross-section will not have changed since recording commenced.
b. The site is very accessible by foot and the gauge reader lives near the gauging site so there is no impediment to gauging the river twice a day as required. There are very few data points missing from the 19 years of record.
c. The gauge was read for 19 years by the father of the present gauge reader, so the family members have an interest in maintaining a high quality record.
d. Test has shown that there is no discernable trend in river flow (increasing or decreasing) since recording began.
e. Runoff per square kilometer from the Sibulan catchment at the gauge is consistent with that from nearby catchments and the shape of the non-dimensional flow duration curves are also similar.
f. There is good correlation between the monthly and yearly runoff totals and the catchment rainfall for the same periods.

Energy Generation { TC "**Section 5.0 Energy Generation**" \f C \l "1" **}**

The Generation Simulation Model for the Sibulan Plant A and B were prepared utilizing the 19 years synthesized flows. Each synthesized daily flow represents a corresponding capacity and power for the different scenarios considered. HSI adopted this procedure rather than using the flow duration curve due to the complexities of the different schemes possible for the Project. This includes controlling the Sibulan Weir to release flows for the Tudaya Falls, daily storage for release during high demand, linking Plant A and B to cascade the effect of pondage at Plant A for Plant B, and the application of the time of use rates averaged at base, shoulder and peak rates.

A base case was identified as the reference capacities for the study while doing schemes of pondages.

1. Flow Used for the Simulation of Power Generation for Sibulan Plants A and B

The result of the hydrologic evaluation was 19 years of synthesized daily flows for both Plants A and B. Plant A has two weirs located at Baroring and Sibulan while Plant B has one main weir located 50 m downstream from the tail water of Plant B and two tributaries along the conveyance line namely; Tomari Intake and Bidaran Intake.

Each flow at the weirs for Plant A was considered separately in the simulation to consider controlling the flow at the Sibulan Weir. Plant B tributaries were treated as additional flows along the conveyance line. Its flows are continuous even with storage at Plant A, when the two plants are linked to cascade the effect of pondage at plant A. As discussed under the Hydrology Section, these flows were the transposed flows from the Cebulan Gauging Station of BRS-DPWH using the ratios of the drainage areas and the specific discharge. The specific discharges as a function of the areas were derived from actual simultaneous flow measurements of Hedcor and BRS DPWH Gauging station along the river.

2. Compensation Flow and Sibulan Weir Flow Control for Tudaya Falls

A compensation flow of 100 lps was considered in the simulation allowing a minimum flow of 100 lps to be available along the river all year round. This amount is deducted in each total flow entering the plants

The series of negotiation on the Tudaya Falls issue resulted into controlling the flow of the Sibulan Weir for Plant A to allow a flow of 1.61cm to pass through the weir for 8 hrs during daytime for the period, January to April. This is to allow flow along the Tudaya Falls during this time of the year for tourists. This was considered in the development of the model.

3. Development of Model for Power Generation

The development of the model took into consideration all the possible scenarios that the spreadsheet would serve. Its objective is to provide information needed for design and revenue assessment. For design, the model is expected to provide the design discharge, net head, capacity and volume of storage. On the revenue side, the model provides the revenue both for generation and demand charge. The revenue is tabulated on a monthly basis.

4. Spreadsheet Preparation for Capacity and Generation Computations

The spreadsheet was prepared making use of the Excel Program of Microsoft. The program's functions were utilized to address the computation requirements of the model. Several worksheets were prepared for parameter inputs, data base, computations, as well as the outputs.

The program is sequenced such that it follows the following steps of computation:

a) calculates the net head,
b) computes for the total flow,
c) deducts the compensation flow,
d) stores flow for pondage schemes or none for base case,
e) calculates duration to fill the pondage with the inputted volume of storage
f) determines duration for run-of-river generation and storage plus run-of-river generation
g) determines the 8 hour peak capacity for each month which could be the lowest (100% exceedence), 95 % exceedence, 85 % exceedence, 75 % exceedence, 65 % exceedence, and 50 % exceedence depending on the risk that the planners would consider.

5. Net Head Calculation

The computation for the net head is simplified in the model. A gross head is inputted and with a fixed percentage of head loss, the net head is calculated. For the two plants, the following are the corresponding gross and net heads:

		Plant A	**Plant B**
Gross Head	:	383.00 m	331.95 m
Head Loss	:	17.40 m	30.94 m
% of Loss	:	4.76 %	9.32 %
Net Head	:	365.60 m	301.00 m

The dimensions of the tunnels and the pipelines were computed based on these heads plus the design discharges of the plants. The dimensions could either increase or decrease depending on the percent of head loss that the designers would consider.

The gross head was set based on the results of the survey and the flood level assessments. A 2 meter allowance is added as freeboard and factor of safety for the flood elevation.

6. Turbine-Generator Efficiency Curve Derivation

The turbine-generator efficiency was based on the efficiency submitted by the EM Contractor. The peak efficiency for the turbine and generator was estimated to be **87.17%** with the generator efficiency rated at 95%.

7. Connection of Plant A and Plant B Cascading the Effect of Pondage at Plant A

As mentioned previously, Plant A and B are linked to consider the stored water at Plant A for Plant B. This is done by connecting the calculation spreadsheets of Plant A and B. The basic consideration for both, when both stores water, is that they release during the 8 hour high demand period, thereby increasing the capacity during this period.

The computation also considers the travel time of the stored water at Plant A to reach Plant B. This duration varies depending on the amount of water that is released from storage. The travel time ranges from 30mins to 1hour.

Connecting Plant A and Plant B also considered the controlled flow along the Sibulan Weir of Plant A releasing a flow 1.61cm for the Tudaya Falls. There is an overlapping period of storage releases with run-of and the control of flow at the Sibulan Weir during the 8 hour period from January to April. The effect is on the generation as reflected in the simulation.

9. Base Case and Pondage Schemes Description

The Base Case was the reference design of the study. It is a case where pondage was not considered, thereby relying entirely on the run-of river potential of the Project. With this scheme, the two plants operate independently in terms of flow utilization.

The Pondage Schemes were considered to possibly increase revenue though operating higher capacities during high rates, particularly during the peak rate and producing higher capacity during the 8 hour high demand load. This scheme stores water at Plant A alone or both at Plant A and B. Due to space limitations, the volume of storage considered for study could be up to 70,000 m^3 for Plant A and 50,000 m^3 for Plant B. When Plant A stores water, this has a corresponding effect on Plant B both while storing and when releases occur. The optimum volume of storage is determined by combining this revenue with the corresponding costs for every different volumes considered.

10. Summary of Results

The results show the design discharges, capacities, and gross generation for Plants A and B. The following are computed outputs for the base case:

		Plant A	**Plant B**
Design Discharge	:	5.27 cm	10.09 cm
Pondage Scheme	:	70,000 m^3	50,000 m^3
Net Head	:	365.60 m	301.00 m
Capacity	:	16,500 kW	26,000 kW
Gross Generation	:	92,049,988 kW-hr	124,375,482 kW-hr

Table 03 – Sibulan Gross Generation Simulation Summary

Month	**Generation (kW-hr)**		
	Plant A	**Plant B**	**Total**
January	7,766,408	10,483,804	18,250,213

February	6,463,977	8,648,555	15,112,532
March	6,619,753	8,852,834	15,472,587
April	6,350,026	8,527,669	14,877,695
May	7,770,110	10,485,079	18,255,190
June	8,296,336	11,319,668	19,616,004
July	8,535,516	11,543,624	20,079,140
August	8,076,533	10,889,781	18,966,314
September	8,017,029	10,817,756	18,834,785
October	8,385,585	11,366,536	19,752,121
November	8,138,214	11,162,681	19,300,895
December	7,630,500	10,277,493	17,907,993
Total	**92,049,988**	**124,375,482**	**216,425,470**

For the pondage scheme, storage of 70,000 m^3 for Plant A is most appropriate since with this volume, the incremental revenue is still expected to increase. However, the space is only limited to this amount. For Plant B, it is observed that the maximum volume that can be considered based on revenue could be settled at 50,000 m^3. Increasing further from this value would result to a decrease on the revenue. This is so because the limit for storage at Plant B is already reached and that increasing the volume further would only result to decreasing the generation of Plant B without any increase in the revenue. The Pondage Scheme for Plant A and Plant B use the same design discharges and capacities.

The gross head on the plants, considered to be the difference in elevation between the main headpond water level and the turbine runner centreline, has been taken from the recently surveyed topographic maps and data provided by the Mechanical and Electrical consultants engaged by the proponent. Friction and form losses in the tunnels and pipelines were calculated using conventional formulae and methods supported by relevant prototype data, to allow the net head on the units to be determined over the range of flows that will be encountered. Machine efficiencies and reasonable downtime allowances were based on similar units operating elsewhere.

A twenty five (25) year operation of the plants was simulated using the 19 years of flow data derived for the intake sites. An allowance was made to release water past the weirs when necessary to provide the legal environmental flows, and to maintain flow at the Tudaya Falls at certain times, as agreed with local community groups. The results provided in Table 5 illustrates the annual net generation of the Plants for the next 25 years, taking into account plant losses that will transpire such as station power consumption, transformation losses, transmission losses, and deterioration of plant machineries and equipment represented as the Generation Reduction Factor over the 25 year lifespan. Provided below are the parameters for plant losses that are deducted from the simulated gross generation:

Table 4 – Sibulan Plant Loss Parameter

Parameter	% of Gross
Gen Reduction Factor /year	0.10%
Transformation loss	1.20%
Transmission Loss	0.6%
Station power use	0.17%

Table 05 – 25 Year Generation Forecast, MW-hr

Plant A													
Years	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**TOTAL**
Base Case	7,766	6,464	6,620	6,350	7,770	8,296	8,536	8,077	8,017	8,386	8,138	7,631	92,051
2009	7,613	6,337	6,490	6,225	7,617	8,133	8,368	7,918	7,859	8,221	7,978	7,481	90,240
2010	7,605	6,330	6,483	6,219	7,609	8,124	8,359	7,910	7,851	8,213	7,970	7,473	90,146
2011	7,598	6,324	6,477	6,212	7,602	8,116	8,351	7,902	7,843	8,204	7,962	7,466	90,057
2012	7,590	6,318	6,470	6,206	7,594	8,108	8,342	7,894	7,836	8,196	7,954	7,458	89,966
2013	7,583	6,311	6,464	6,200	7,587	8,100	8,334	7,886	7,828	8,188	7,946	7,451	89,878
2014	7,575	6,305	6,457	6,194	7,579	8,092	8,326	7,878	7,820	8,180	7,938	7,443	89,787
2015	7,567	6,299	6,451	6,188	7,571	8,084	8,318	7,870	7,812	8,172	7,930	7,436	89,698
2016	7,560	6,292	6,444	6,181	7,564	8,076	8,309	7,863	7,804	8,163	7,922	7,428	89,606
2017	7,552	6,286	6,438	6,175	7,556	8,068	8,301	7,855	7,796	8,155	7,914	7,421	89,517
2018	7,545	6,280	6,431	6,169	7,549	8,060	8,293	7,847	7,789	8,147	7,906	7,413	89,429
2019	7,538	6,274	6,425	6,163	7,541	8,052	8,284	7,839	7,781	8,139	7,898	7,406	89,340
2020	7,530	6,267	6,419	6,157	7,534	8,044	8,276	7,831	7,773	8,131	7,890	7,399	89,251
2021	7,522	6,261	6,412	6,151	7,526	8,036	8,268	7,823	7,765	8,123	7,882	7,391	89,160
2022	7,515	6,255	6,406	6,144	7,519	8,027	8,260	7,816	7,758	8,115	7,875	7,384	89,074
2023	7,507	6,249	6,399	6,138	7,511	8,019	8,251	7,808	7,750	8,106	7,867	7,377	88,982
2024	7,500	6,242	6,393	6,132	7,503	8,011	8,243	7,800	7,742	8,098	7,859	7,369	88,892
2025	7,492	6,236	6,387	6,126	7,496	8,003	8,235	7,792	7,734	8,090	7,851	7,361	88,803
2026	7,485	6,230	6,380	6,120	7,488	7,995	8,227	7,784	7,727	8,082	7,843	7,355	88,716
2027	7,477	6,224	6,374	6,114	7,481	7,987	8,218	7,777	7,719	8,074	7,835	7,347	88,627
2028	7,470	6,217	6,367	6,108	7,474	7,979	8,210	7,769	7,711	8,066	7,827	7,340	88,538
2029	7,463	6,211	6,361	6,102	7,466	7,971	8,202	7,761	7,703	8,058	7,820	7,332	88,450
2030	7,455	6,205	6,355	6,095	7,459	7,963	8,193	7,753	7,696	8,050	7,812	7,325	88,361
2031	7,447	6,199	6,348	6,089	7,451	7,956	8,186	7,744	7,688	8,042	7,804	7,318	88,272
2032	7,440	6,193	6,342	6,083	7,444	7,948	8,177	7,738	7,680	8,034	7,796	7,310	88,185
2033	7,432	6,186	6,336	6,077	7,436	7,940	8,169	7,730	7,673	8,026	7,788	7,303	88,096
AVERAGE	**7,522**	**6,261**	**6,412**	**6,151**	**7,526**	**8,036**	**8,268**	**7,824**	**7,766**	**8,123**	**7,883**	**7,391**	**89,163**

Plant B													
Years	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**TOTAL**
Base Case	10,484	8,649	8,853	8,528	10,485	11,320	11,544	10,890	10,818	11,367	11,163	10,277	124,378
2009	10,277	8,478	8,679	8,360	10,278	11,097	11,317	10,675	10,605	11,143	10,943	10,075	121,927
2010	10,267	8,470	8,670	8,352	10,268	11,086	11,305	10,665	10,594	11,132	10,932	10,064	121,805
2011	10,257	8,462	8,661	8,343	10,258	11,075	11,294	10,654	10,584	11,121	10,921	10,054	121,684
2012	10,247	8,453	8,653	8,335	10,248	11,064	11,283	10,643	10,573	11,110	10,910	10,044	121,563
2013	10,236	8,445	8,644	8,327	10,237	11,053	11,271	10,633	10,562	11,099	10,899	10,034	121,440
2014	10,226	8,436	8,635	8,318	10,227	11,042	11,260	10,622	10,552	11,087	10,888	10,024	121,317
2015	10,216	8,428	8,627	8,310	10,217	11,031	11,249	10,612	10,541	11,076	10,878	10,014	121,199
2016	10,206	8,419	8,618	8,302	10,207	11,020	11,238	10,601	10,531	11,065	10,867	10,004	121,078
2017	10,196	8,411	8,609	8,293	10,197	11,009	11,226	10,590	10,520	11,054	10,856	9,994	120,955
2018	10,185	8,402	8,601	8,285	10,186	10,997	11,215	10,580	10,510	11,043	10,845	9,985	120,834
2019	10,175	8,394	8,592	8,277	10,176	10,987	11,204	10,569	10,499	11,032	10,834	9,974	120,713
2020	10,165	8,386	8,584	8,268	10,166	10,976	11,193	10,559	10,489	11,021	10,823	9,964	120,594
2021	10,155	8,377	8,575	8,260	10,156	10,965	11,182	10,548	10,478	11,010	10,812	9,954	120,472
2022	10,145	8,369	8,566	8,252	10,146	10,954	11,170	10,538	10,468	10,999	10,802	9,944	120,353
2023	10,135	8,361	8,558	8,244	10,135	10,943	11,159	10,527	10,457	10,988	10,791	9,934	120,232
2024	10,124	8,352	8,549	8,235	10,125	10,932	11,148	10,516	10,447	10,977	10,780	9,924	120,109
2025	10,114	8,344	8,541	8,227	10,115	10,921	11,137	10,506	10,436	10,966	10,769	9,915	119,991
2026	10,104	8,336	8,532	8,219	10,105	10,910	11,126	10,495	10,426	10,955	10,759	9,905	119,872
2027	10,094	8,327	8,524	8,211	10,095	10,899	11,115	10,485	10,416	10,944	10,748	9,895	119,753
2028	10,084	8,319	8,515	8,203	10,085	10,888	11,103	10,474	10,405	10,933	10,737	9,885	119,631
2029	10,074	8,311	8,507	8,194	10,075	10,877	11,092	10,464	10,395	10,922	10,726	9,875	119,512
2030	10,064	8,302	8,498	8,186	10,065	10,866	11,081	10,454	10,384	10,911	10,716	9,865	119,392
2031	10,054	8,294	8,490	8,178	10,055	10,855	11,070	10,443	10,374	10,900	10,705	9,855	119,273
2032	10,044	8,286	8,481	8,170	10,045	10,845	11,059	10,432	10,364	10,890	10,694	9,845	119,155
2033	10,034	8,277	8,473	8,162	10,035	10,833	11,048	10,422	10,353	10,879	10,683	9,836	119,035
AVERAGE	**10,155**	**8,378**	**8,575**	**8,260**	**10,156**	**10,965**	**11,182**	**10,548**	**10,479**	**11,010**	**10,813**	**9,954**	**120,476**

The monthly generation for 25 years were then averaged to attain the mean generation figures, which were used for the calculation for the carbon emission reductions:

Table 6 – Average Monthly Generation (kW-hr)

AVERAGE MONTHLY GENERATION (kWhr)		
Month	**PLANT**	
	Plant A	**Plant B**
January	7,522,746	10,154,887
February	6,261,177	8,377,216
March	6,412,065	8,575,086
April	6,150,801	8,260,123
May	7,526,332	10,156,121
June	8,036,048	10,964,525
July	8,267,724	11,181,456
August	7,823,140	10,548,126
September	7,765,504	10,478,361
October	8,122,496	11,009,924
November	7,882,887	10,812,464
December	7,391,102	9,955,048
TOTAL	**89,162,021**	**120,473,337**
GRAND TOTAL	**209,635,358**	

The assessment of monthly and annual energy for the Project Plants A and B have been prepared on the basis of 19 years of high quality flow records in the Sibulan River basin at a gauging site located 3 km downstream from Plant B powerhouse and plant characteristics as presently envisaged. The forecasted outputs from the Project Plants A and B are:

Plant A

1. Average Annual Energy — 89.16 GWh/yr.
2. Expected range of annual energy in a 25 year period. — 90.24 to 88.09 GWh/yr.
3. Average Energy in the minimum month (April) — 6.16 GWh
4. Average energy in the maximum month (July) — 8.27 GWh

Plant B

1. Average Annual Energy — 120.47 GWh/yr
2. Expected range of annual energy in a 25 year period. — 121.92 to 119.03 GWh/yr
3. Average energy in the minimum month (April) — 8.26 GWh
4. Average energy in the maximum month (July) — 11.18 GWh

Appendix 10. Document of Stakeholders' Consultation

Table of Consultative Meetings Held for the Project

Date	Venue	Agenda	Attendees
March 4, 2005	Kapatagan, Digos City	Preliminary Consultative Meeting	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - EMB Region 11 - Department of Energy - Maunsell Philippines
April 14, 2005	Lower Pogpog, Sibulan, Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Matanao Service Center - Hedcor, Inc.
April 23, 2005	Sibulan, Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Tribal Council of Sibulan - Matanao Service Center - Hedcor, Inc.
May 26, 2005	A&B Hotel, Digos City	Drafting of Memorandum of Agreement (MOA)	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Hedcor, Inc.
June 06, 2005	Sibulan Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members of Bagobo and Tagabawa (Including chieftain, elder) - Hedcor, Inc.
June 10, 2005	Lower Pogpog, Sibulan Sta. Cruz, Davao del Sur	Community Assembly	Representatives from: - National Commission for Indigenous Peoples - Barangay Sibulan, Tribe members from Tagabawa and Bagobo (Including chieftain, elder) - Hedcor, Inc.
June 11, 2005	Sibulan Sta. Cruz, Davao	Signing of Memorandum of Agreement	Representatives from: - National Commission for Indigenous

	del Sur		Peoples - Barangay Sibulan, Tribe members of Bagobo and Tagabawa (Including chieftain, elder) - Hedcor, Inc.