A FULL – BLOWN FEASIBILITY STUDY REPORT

PROPOSED UPPER SEPAKA MICRO – HYDROPOWER PROJECT

Upper Sepaka, Surallah, South Cotabato

Prepared by:

YAMOG Renewable Energy Development Group, Inc.

In Partnership with:

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and

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Summary of Project Specifications

System Component	Specification
Project name	Upper Sepaka Micro-hydro project
Source	Sepaka River
Location	Bgy. Upper Sepaka, Surallah, South Cotabato
Load Centers	Barangay Upper Sepaka Proper
Distance from nearest road-head	With Good all weather road passable all year round
Overall design parameter	Gross head from forebay tank water level to penstock / turbine center line at powerhouse ~ 4.54m; Minimum flow required at intake during low flow season 2000 l/s 218 masl Water quality - contains a small amount of lime Operation – manual and off grid Ambient temperature – 30 degrees Celsius
Hydrology	Catchment area –121.24 sq. km.
Measured flow and date	4.7cm3 June 1, 2006
Turbine design Discharge	2000 l/s
Gross Head	4.54 m
Net head	4.48
Installed Capacity	40kw (high efficiency propeller turbine)
Intake	0.60 m x 1.35m x two (20 units Side intake through coarse trash rack and MS sluice gate to control the inflow
Wing wall	4m tall at 8 meters length RCC flood protection wing wall
Gravel trap	2.7m x 1.9 m at 12 meter length RCC construction gravel trap with spillway and six (6) inches pipe for flushing
Headrace canal	1.9m x 1.9m at 123 meters length rubble masonry canal and 552 meters earth canal.
Forebay	3.1 m x 4 m at 16.7 meters in length and CHB with steel reinforce structure and fine finished walling with spillway, flushing pipe and fine trash-rack
	Appropriate flange at lower end to connect to inlet valve of the equipment inside the powerhouse
	Allowance for surge head of 20% of static head throughout.
Turbine	1 unit of propeller turbine with manual flow controller
	Able to withstand runaway speed for one hour minimum
	Turbine rated to operate at 4.54m gross head and 2000 l/s flow and produce 40 kW shaft output
	Precision pressure gauge installed on adapter pipe or turbine manifold

Powerhouse	~ 4m x 5m floor area; RCC construction with Corrugated sheet roofing
	Metal roofing and all exposed metal parts of equipment to be grounded along with the generator neutral for optimum lightning protection
Speed transmission	V – belt speed transmission system
Generator	OPTION I – AVR type Self excited self regulated synchronous generator; 3 phase 4 wire, Class H insulated, rated to supply 50 KVA continuously at 0.8 power factor at class F temperature rise, 230/460 V, 60 Hz, 4 pole. OPTION II – Self excited self regulated synchronous generator (Made in China, ICHI Brand) class B insulated
	Able to withstand runaway speed for one hour minimum
Governing	Rated to continuously dump a total of 40 kW minimum, 3 phase stepped load (binary) type Electronic Load Controller (ELC); ELC should be frequency sensing type; The ELC must equally distribute surplus power on all three phases irrespective of unbalanced feeder load.
	Ballast load consisting immersion heaters in a separate mild steel tank or equivalent air heaters
	Recommended separate regulator control boards for each phase especially if turbine and generator can not withstand runaway speed
Tailrace	1 m wide x 1.1 m high ~ 35m long open CHB reinforced 10mm RSB with gabion (1m x 1m) at the lower end
Transmission length 7,620V	1,700 mters
Distribution length 240 V	1,800 meters
Total beneficiary households	300 households
Comm. & Ind. End uses	Household lighting, TV, community video (in school), battery charging, refrigeration and bakery

Main inlet valve	24”Ø ID manually operated butterfly valve with gear mechanism OR 24”Ø ID manually operated gate valve with pressure equalizing by-pass
	Valve rated 1.5 x maximum water pressure including surge
Pipe adapters	Flexible coupling with adapter pipes to connect to valve upstream and turbine manifold down stream
Pressure gauge	Precision pressure gauge installed on adapter pipe or turbine manifold
Regulator	Voltage or frequency sensing (as suitable) Electronic Load Controller (ELC) with resistive immersion water (and / or air) heaters as dump loads; Regulator should be compatible with the generator
	Recommended separate regulator control boards for each phase especially if turbine and generator can not withstand runaway speed
Control panel	Free standing metal cubicle with necessary indicators, instrumentation including a hour-run meter and protection against over load and short circuit

Recommended controls	Over current – trip breaker
	Short circuit – trip breaker
	Over voltage (5%) – de-excite
	Starting up – manual
	Shutdown – manual

Plant loading	The generator is loaded on only two of its three phases; Expected resultant load power factor is 0.54 lagging
High tension Transmission Line	Line length and type of each sector Powerhouse to Brgy. Proper – 1,700 meters, 3phase 4 wires of 14mm2 ACSR 7,620kV overhead line
LT Distribution Line	Line length and type of each sector Brgy. Distribution – 1 phase 2 wires of 14mm2, ACSR and 14mm2 AAC 240 V overhead line
Line protection	HT lines: Pole mounted HT lightning arresters for the phase lines at the start and end of each HT line section with cut out fuse link
	LT lines: Pole mounted LT lightning arrester for the phase lines at the start and end of each LT line section
Poles	HT lines: 8 m long treated wooden poles minimum 8” diameter at top and minimum 10” diameter at bottom
	LT lines: 7 m long Locally treated wooden poles minimum 6” diameter at top and minimum 8” diameter at bottom
Insulators	HT lines: Pole Top Pin and Pin type, single upset bolt and spool insulator rated for 7,620 V
	LT lines: Shackle / spool type insulator with D-iron
Total beneficiary households	300 households
Community end-uses	Evening lighting including - One elementary school @320 watts - Two mosques @ 150 watts Forty numbers of 18 watts high power factor CFL street lamps for evening lighting

Commercial / Industrial end-uses	*Off-peak hour end-uses including* - 1 x 250 watts for TV/Video for school - 20 x 200 watts for refrigerator - 34 x 100 watts for household TV and Video CD - 1 x 1500 watts for battery charging for lighting of houses outside the micro-grid - 2 x 2000 watts for bakery - 1 x 2000 watts for blacksmithing - 1 x 8000 watts rice mill - 1 x 2000 watts for grains grinder
Comm. & Ind. End uses	Community video (in school), battery charging , bakery, public lighting and blacksmithing
Total plant construction cost	P 4,860,111.32
Plant factor	61%
Proposed tariff	Capacity of the community people to pay as per data collected during the household interview which is Php80.00 minimum and Php100.00 maximum

I. INTRODUCTION

The Municipal Local Government Unit of Surallah in its intention to provide assistance to off-grid community in one of their barangays has asked the technical assistance of YAMOG in determining the technical feasibility study of the proposed micro hydropower in Bgy. Upper Sepaka in Surallah municipality. A site survey was made with the YAMOG technical staff team together with the team from the MLGU Surallah in April 2006. Having seen the project site and after having conducted the pre-feasibility study, it was found out that the project is worth pursuing and recommended for the technical feasibility. The MLGU then advised YAMOG to pursue with the full-blown technical and social feasibility study of the proposed micro hydropower project

YAMOG technical team conducted feasibility studies to determine the demand for electricity and the potential power supply of the different sites. The local NGO based in Surallah, the Gentud Foundation, Inc is identified as the local partner with its present project in the barangay and its organizer assisted in the social investigation.. Focused group discussions and household survey was conducted to look at the current energy usage, their income and their expenditures pattern, household consumption of fuel, their priority needs for electricity, and their capacity and willingness to pay for the electricity. The community validated the results of the survey.

These are detailed feasibility study (technical and social) of the proposed micro hydropower carried out by technical local consultants representing micro hydropower engineer, mechanical, civil, electrical engineers, and social development experts.

II. FINDINGS AND RECOMMENDATIONS

The project is technically feasible and socially acceptable. It responds to the community need for electrification and ensures sustainability scheme to ensure that the project operates in the long run.

1. Demand and Supply

The total expected installed capacity at present resulting from total potential electricity consumers of 300 (1 school, 1 mosque, 40 street lighting and 1 battery charging station, 2 bakeries). The details of the load demand and proposed load management is given in the later chapter.

It should be noted that for better lighting efficiency all lamps should be of CFL or mercury tube lamp type. And with the poor power factor of 0.5 of such normally available lamps care should be taken to determine the equipment feature to meet the reactive load demand. The same also holds recommended power factor improved CFL lamps be used for lighting and the motor loads true for starting KVA requirement due to the need to start at least twenty units of 200 watt refrigerators and bakery of 2 units at 2 kilowatts starting KW requirements. Hence on the end-use side it is strongly must be 3 phase star delta started.

The flow measured at site during lean season and the maximum head that is easily obtainable should be just sufficient to meet the projected need of 40kW. The site is suitable for Pump-as turbine (PAT). With locally built pump as turbine the needed output of 40 kW may be possible to generate but care has to be taken with regard to the efficiency of the turbine and use of high power factor lamps (to improve efficiency of the generator). With a Pump-as-turbine, the expected power output from the plant might be in the range of 40 kW (with some increased cost on the turbine).

2. Summary of Costs

Micro-hydro plants are site specific and so are their costs. The deciding variables being remoteness, gradient of waterway between intake and tail race, energy density of service area and design/construction features. The proposed design/construction features are aimed at striking a balance between cost and reliability of the plant. The proposed design has taken into consideration site remoteness, availability of local resources like labor and materials, future management capability of the user's committees, reliability of supply and off course cost. The construction costs arrived at a result of the tentative construction drawings and analysis of the construction rates for the site. Since the feasibility survey and analysis has been done in sufficient details we do not expect a appreciable variation at the time of the actual construction. (*Please See Annexes 8-A to 8-C for and drawings for details and justifications for the costs. The following is the summary).*

Direct Construction Cost:		
Waterways and powerhouse	P	2,919,544
Generating Equipment		3,231,300
Distribution lines		895,588
Total Direct Cost @ PhP 105,000 / KW	P	7,046,433
Indirect Construction Cost:		
Management training of Village Electrification Comm	P	100,000
Supervision/ coordination direct cost by YAMOG		300,000
Transportation Cost		150,000
Food for Work		112,500
Total Indirect Cost	P	662,500
End -use and infrastructure for income generation and livelihood component costs:		
Rice Mill		300,000
Grains Grinder		40,000
Bakery		135,000

Battery charging station and building		250,000
Total Livelihood Costs	P	725,000
Total direct+indirect+end-uses+livelihood costs		8,433,933

3. Capability to Pay / Willingness to Pay

A household would spend an average of PhP80.00 to PhP100 per month for the energy (current use kerosene) for their household lighting. Majority of the community members are willing to pay more for the quality electricity from the micro- hydropower. The community members have the capacity to have their income derived from corn production and other agricultural crops and would be wiling to pay for the electricity. As per tariff structure, based on the results of the energy demand and social survey, an average of Php50.00 to PhP100.00 per month is affordable to most of the community members. Strong community preparations need to be done as the idea of the project is to unite these two communities as the proponent of this proposed project.

4. Proposed Financing Structure

As YAMOG concept, the micro hydropower plant would be a community owned type, non-profit making, addressing the need of sustainability and enterprise development, attempt should be to address to social equity and bring all community members to the mainstream of conservation, encourage villagers to operate the plant successfully, ensure sustainability and also raise funds for community development from the revenue collected so that the development process gets rolled on to some extent by itself. The community could contribute community labor during land clearing, hauling of some construction materials and house wiring. However, from past experiences in the Philippines and other countries, free labor contribution to the tune of a maximum of 5% may be feasible. The rest will have to be in the form of paid labor.

5. Financial Viability

An estimate has been made based on experiences (see Annex 4) for operating expenses toward wages of operating staff, regular maintenance / replacement requirement and any administrative costs results in a annual operating cost of PhP **Error! Not a valid link.**. Allowing for linear depreciation over 15 years at an annual inflation rate of 4% and assuming no salvage value at the end of its operating life, the total annual cost might be PhP468,691.52. Based on the estimate of energy to be sold, the present energy production cost could be about PhP 14.34 per kWh with full depreciation and PhP 11.03 per kWh with no depreciation. However, in future the demand is going to grow more in relation to the cost and hence the energy production cost would be lower.

The resulting tariff with 25% revenue set aside for community development fund and full depreciation taken into account would look as follows.

Domestic lighting at 13hrs connection/day	P 14.34/kWh
Battery charger	P 20.43/kWh

The above rates are practical and affordable compared to the present cost of conventional energy sources. With community development fund incorporated in the tariff and maintenance / replacement / depreciation taken care of the plant is financial viable from the first year of its operation. In reality the development fund should increase (or conversely the tariff could be relaxed in future as the load factor grows). *Please see Annex 5 & 6 for details of estimations on operation cost, load factor, energy costs and suggested tariffs.*

6. Trainings and Management

The Upper Sepaka Barangay Power Association (BAPA) will be organized to work together in the whole process of project implementation and to eventually manage the plant after the construction is completed and handed over to them. Proper selection of BAPA members, introducing and enforcing guidelines for operation of the BAPA and

electricity rules will help sustain the project. The BAPA formed to manage the micro-hydropower project is composed of active leaders of Upper Sepaka. All household beneficiaries are BAPA members and act as the General Assembly.

Local operators are identified by the community which would undergo on- the- job training and non-formal training courses on basic electricity, household wiring installation, mechanical work and other related training courses (through TESDA accredited training institutions like academe).

Furthermore, financial management and other capability building trainings would be conducted to enhance the management capability of the leaders. Enterprise development training would also be conducted to enhance the skills and capacity of the leaders on entrepreneurial development.

7. Other Recommendations

a) Organizational / Social Aspect

Well thought out plan for social preparations should be developed with maximum participation of the community members with the barangay leaders and respected community leaders.

Organizational development (through BAPA) representing the community needs to be addressed in order for it to be capable to manage and sustain the micro-hydropower project and other socio-economic and sustainable livelihood projects using the available power from the micro hydro. Continuing community capability building (such as financial management, bookkeeping and other technical trainings) is important to be given priority attention to enable the leaders and members with the upgraded knowledge and skills in the successful management of their community-based micro hydropower project and community-initiated development projects. The community is capable and willing to pay for the energy premiums. Community mobilization should be enhanced to promote active participation in installation and post-installation phase of the project.

b) Management Capacity to handle Community Development Projects

To prepare the community to implement micro hydro power project, it might help if they can demonstrate their community capacity or the barangay to undertake other community development projects like potable water system which is already completed in partnership with the other NGO's. The experience that the community would gain from this experience would be a necessary and community learning experience for them to undertake a much bigger challenge of renewable energy and natural resource a management.

c) Project Development and Construction of Scheme

Given the experiences of YAMOG in doing community-based renewable energy systems in Mindanao, the community-based approach of doing the actual construction will be done with active community participation in the project planning, implementation and project monitoring.

d) Role of Partners

<u>Community / Upper Sepaka BAPA:</u>

Community mobilization for participation in the pre- construction, actual construction through voluntary labor in hauling of sand, gravel and other construction materials, taking care of equipment and materials brought in the area in their custody, etc. and other community participation in terms of house wiring and other community initiated projects / post-installation like the watershed management and protection activities to promote local environmental initiatives. Food for work is however, recommended, for the day's work since most of them are subsistence farmers. Other schemes to ensure community participation as needed and also promote greater community ownership and

sustainability include and hands on training for potential operators and leaders of the organization, active involvement in the monitoring and evaluation of the project is ensured

GENTUD Foundation, Inc..

GENTUD Foundation, Inc is a partner NGO of this proposed project. An NGO based in the municipality of Surallah it has on-going development projects like providing support to students through books and reading materials to the elementary school in Brgy. Sepaka and facilitated the introduction of water sealed type of latrines in some of the community residents there. It has then established partnership with the community residents and has gained support from the community to enable them to develop community development projects with active participation by the community. As such, because of their long experience in working with the community, it has the capacity to act as one of the proponents, as the lead implementing organization with the main role of ensuring the community preparations and community organizing so that active participation of the project is always enhanced. This would enhance greater sense of community ownership as a community initiated, community-managed, and community-owned micro hydropower project. It would facilitate skills capability building training among the leaders and members to equip them with knowledge and skills in managing their project.

YAMOG

Being the party responsible for technical feasibility study, YAMOG could best provide services for technical supervision and coordination during the pre-construction, construction and post-construction periods including assisting with pre-construction activities, train local leaders and operators, post-installation monitoring & evaluation work etc.

e) Watershed /Environmental Situation

Vegetation surrounding the Sepaka River and the source of water in the watershed area is filled with a few secondary growth dipterocarp forest ecosystems. A very limited species of hardwood trees were noted in the remaining watershed area. However, it is observed that there are significant areas that are prone to landslips/landslides. So there is a need for a long-term plan for watershed protection and maintenance. There is need for a long-term plan to ensure environmental protection. The vegetation in the area needs to be improved firstly for ensuring perennial flow for the micro-hydro secondly for protecting against landslides and also for improving biological ecosystem. There is no negative environmental effect resulting from the micro-hydro project.

A Natural Resource Management plan has to be formulated and implemented with active community participation and other stakeholders of the project. Close coordination with the LGU (both at the barangay and municipal levels) has to be done to ensure project sustainability of the NRM and social projects that the community would take.

III. GENERAL AREA DESCRIPTION

This part of the study describes the project location and accessibility, topography and vegetation, and watershed.

1. The Province of South Cotabato

Situated in the southern part of Mindanao, South Cotabato, is bounded on the west and North by Sultan Kudarat and in the east and south by the City of General Santos. Its vast mountain ranges, particularly the Daguma Range, the Allah and Koronadal Valleys and the Roxas Mountain Range contributed to its distinct physiographic features. It has a total land area of around 33,756.92 square km. The province is home to T'boli, B'laan tribes and Christian settlers.

The province's economy is predominantly agricultural in which the major crops include rice, corn and coconut.

2. Surallah Municipality

Being the largest municipality of South Cotabato, it occupies a total land area of 31,200 hectares, dotting a growing rural population of 42,467 individuals (as of 1995 Census of National Statistics Office). It is basically a major plain area- a rice producing and corn producing municipality of South Cotabato. It is bounded in the north by the Municipality of Banga in the south by the Municipality of Lake Sebu, in the west by the Province of Sultan Kudarat and in the east by the municipalities of Banga and T'boli.

3. Barangay Upper Sepaka

Barangay Upper Sepaka is one of the 17 barangays of the municipality of Surallah, South Cotabato, Province of South Cotabato. Comprised of a total land area (1,824 hectares), according to its Barangay Land Use, the barangay is 4.35% forested area, and most of the land is agricultural (about 94.19 %). This means that the main source economic activity of the Barangay is farming (majority corn and rice).

However, the barangay is characterized by plateaus and topography is mostly rolling and sloping areas which is mainly suitable by sloping agricultural land technology (SALT).

The barangay is composed of Twenty Three (23) sitios. It is populated with around 566 households scattered in different clusters predominated by Muslim tribes.

4. Location and Accessibility

Barangay Upper Sepaka is located 27 kilometers from the municipality of Surallah, being one of the farflung Muslim,Christian and Lumads communities. It is around 10 kilometers away from the nearest power grid.

Barangay Upper Sepaka can be most easily accessed from the municipality by taking a motorbike or a four-wheel drive vehicle.

5. Climatic Conditions

The climate in this region is categorized as Type IV with no pronounced dry and rainy season or rain is evenly distributed through out the year. The dry season generally occurs during the months of November to April, while rainy season is from May till October. There is a rain gauge station in the Surallah municipality. The average monthly temperature is 27.8 C and the area is typhoon free.

6. Topography and Vegetation

Barangay Upper Sepaka is situated at its highest elevation of 218 meters above sea level. It is one of the watershed areas of the municipality of Surallah. The terrain is rugged and highly mountainous with a highly rolling topography. A significant watershed area is still covered with vegetation and a home to flora and fauna. Cultivated agricultural land is extensive with corn and other crops and a few fruit trees.

Most of the residents have already been given a secured status of tenure as most of the lands were already distributed among the settlers of the barangay. 35 % is public land, land-owned about 40% while the tenants are about 25%.

7. Demographic Profile

Population size, projection and Distribution

Based on the NSO survey, the total population of Barangay Upper Sepaka is 566 (as of 1999) with a total population of over 2,536 individuals. This number indicates a 3.1 % increase in the population growth. The average family size is 5 –6 persons. This is compared to a nationwide average of 2.3% suggesting a doubling of the population within the next thirty (30) years.

Barangay Upper Sepaka is predominantly Muslim.

Literacy rate in the barangay is placed at 98% based on the ten years old and above.

IV. STUDY METHODOLOGY

Availing of the expertise of a local surveying team, the technical team together with the social development experts headed towards the project site armed with engineering surveying equipment, the total distance measurement (TDM) device to measure and determine the actual lay out of the different structures of the proposed micro hydro project from the intake to the powerhouse to the distribution centers of the barangay. A topographic profile of the site indicates the actual lay-out and the needed excavation and other civil works that goes with the actual construction of the project. The measurement of the flow was determined through the water current meter and spot flow measurements were compared to the flow taken during the pre-feasibility study phase.

On the other hand, the social development specialists did conduct a focused group discussions and community meetings among the representatives from the community selected at random by the community leaders and the social team to make sure that representation is objectively done. The social team is formed by the staff members of the NGO, the South Cotabato Tri-People GENTUD Fdn., Inc. based in Surallah, South Cotabato who has also an on-going project on sustainable farming, day care center and have therefore direct knowledge and accessibility to the community members. Primary data on the community's socio-economic and environmental conditions were gathered with the active participation of the members of these communities. Secondary information was gathered from the municipal development planning office. The results of the data gathered are collated and summarized. It is hoped that the results of this technical and social feasibility study would be validated by the community.

V. SOCIO-ECONOMIC CONDITIONS

The Socio-economic Profile contains the community's income sources and household activities, the approximate household income, land ownership, government and non-government support projects and the existing social services.

A. Income and Sources

The majority of the Barangay Upper Sepaka residents (75 % of households) depend on corn farming and of the total farmers and rainfed traditional rice farming, while others plant root crops and other tropical fruit trees. A few are engaged in small business like sari-sari/retailers by few individuals.

As of 1999, the average household income per month for the barangay is PhP 3,500.00. This is way below the national poverty threshold of P 6,000.00 for a family of five (5) in a rural area.

B. Land Ownership/Tenurial Status

The Muslim community which occupies the land area own the land they till (about 40%) of the total population while the rest are tenants (25%). More than 65% of the land is cultivated while the remaining area is considered watershed area as a protected area. The average farm size is about 3 hectares per farmer household. On the agricultural area, there are some 568 hectares which are tilled by the landowners themselves, 76 hectares are tenanted, 6 hectares are considered Voluntary Offer to Sell (VOS), 10 hectares are under OLT/CLT and 101 hectares are being leased for agro-industrial plantation. These corn products are shelled and these are directly marketed by the farmers to the nearby barangays of the municipality of Surallah.

C. Basic Social Services

C1. Education, Health and Sanitation

There are three schools in the barangay that provides education to young children (from 7-years old to 13 years of age). The Upper Sepaka Elementary School (public school) with about 320 pupils, the Maguindanaon Al-Falilah school (managed by the Sta. Cruz Mission of Lake Sebu) and the Madrasabal Sepaka Arabic School (Private schools) with a total enrollees of 267 pupils. The nearest secondary school is in Surallah municipality.

Out of the 490 children (1999) being diagnosed, about 40% are malnourished. Almost 2% are considered severely malnourished while the rest are still at the mild and moderate levels. Most common illnesses are coughs, colds, headache and fever, measles and amoebic dysentery.

Only 28% of the residents have a water-sealed type of toilets, about 34% are using the open pit type, while 38 % remained in their own primitive way of littering in the fields.

Potable Water System

There is an existing potable water system (level 1 and 2 distribution system) that reaches only at the barangay proper while the remotest sitios still depend on fetching water from the springs located quite far from the community itself.

Existing Projects and Area Project Plan

The irrigation facility in the barangay has served the rice farmers in Sitio Datal-alo that serve about 30 hectares of rice farms. The barangay has no solar dryer for their crops except at the school premises of both the elementary and the secondary schools.

Electricity

There is no electricity for the whole population. The nearest power grid is around 10 kilometers away from the nearest power grid and the South Cotabato Electric Cooperative (SOCOTECO) has no plan of extending the power grid to this barangay at least in the next five years. However, there is a need to secure a waiver from the said electric cooperative.

VI. ENERGY DEMAND ANALYSIS

This part of the study presents the potential demand for energy

A. Off-grid Condition

As discussed in the previous section, grid has not been extended to the target community and extending the grid will entail an investment cost of at least P 2M for the transmission line alone. This amount was estimated using the National Electrification Administration (NEA) data on the unit cost of a distribution system per kilometer.

B. Traditional Energy use, Supply and Expenditure Pattern

The residents of Barangay Upper Sepaka use traditional sources of energy, which are common among off-grid communities. There are about 5 households who are benefiting the diesel-fed generator but because of the high cost of maintenance, the generating system is not functioning anymore

B1. Traditional Energy Use

All of the community residents use kerosene for illumination with an average of 4 liters per month. There is no other current form of electricity. All of the residents use fuel wood for cooking.

B2. Energy Supply and Expenditure Pattern

On average, a household spends around PhP80.00 to Php100.00 per month for kerosene (household illumination only).

C. Energy Needs and Priority

If there was an energy system that could provide for the community's load requirement, the community residents identified the following possible uses (according to priority):

(1) Household lighting
(2) Livelihood activities
(3) Lighting for access road/street

Most of the houses would need an average of three to two lamps (at 11 watts lamp) as most of them have only one room with the kitchen located outside with a cover. As there is no electricity in the barangay, the most important need is household lighting for illumination.

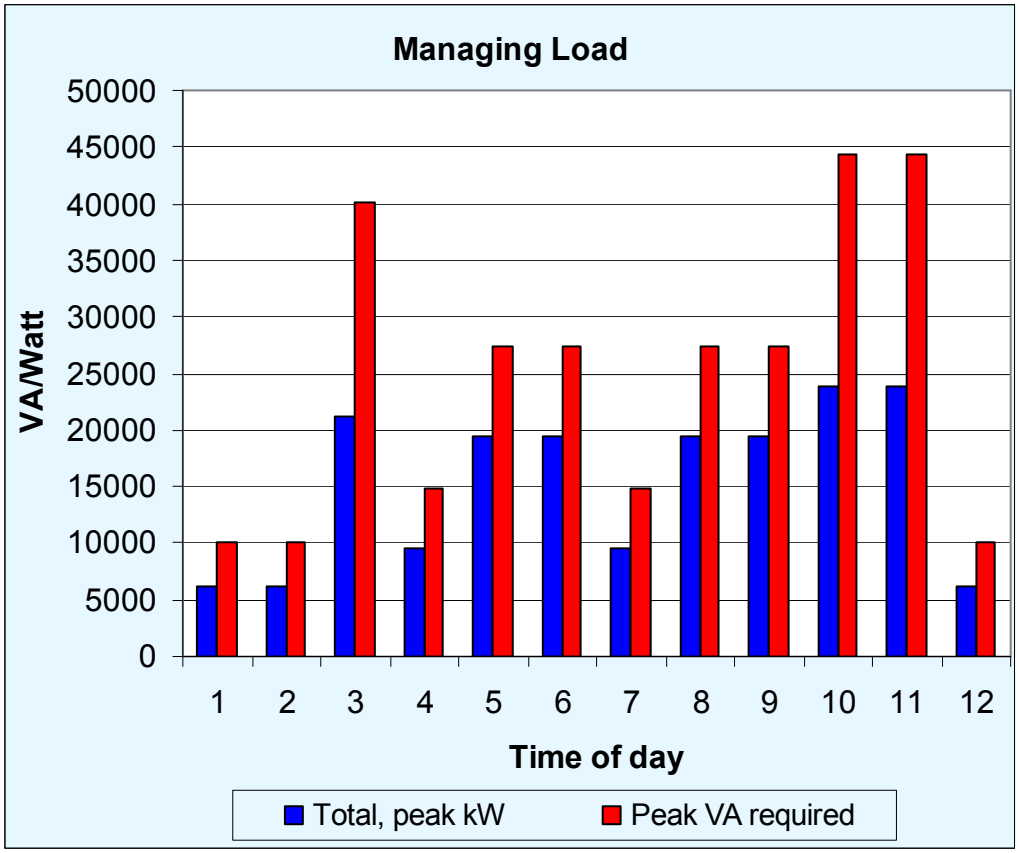
Load	Unit	Rate, watt/unit	Installed peak Watt
House lightng 1	300	50	15000
TV/video	34	100	3400
Street lighting	40	18	720
school lighting	1	320	320
Mosque	1	150	150
School TV/video	1	250	250
Refrigeration	20	200	4000
Bakery (motor)	1	2000	2000
Grains Grinder	1	2000	2000
Battery charging	1	1500	1500
Rice Mill	1	8000	8000
Blacksmithing	1	2000	2000
Total	402	16588	39340

The above table shows that the main usage for electricity is household lighting with the community lighting and community video and low wattage refrigeration. These are the peak load requirements during night at 6 – 8 hours as they can be operated during off peak hours.

The battery charging system would allow households from the nearby community of the barangay and other communities within the barangay to have their batteries charged during the early hours of the morning (12mn – 4am) or during daytime.

Demand Management

A typical demand graph with optimum load management for meeting the Upper Sepaka energy demand and unavoidable peak loads appear as follows. It can be seen that the estimated peak demand with some future growth provision can be met with the potential of the site.



VII. TECHNICAL STUDY

This technical study presents the viability assessment of the water source for micro hydropower generation for household electrification and productive end-uses of Barangay Upper Sepaka, Surallah, South Cotabato

1. Hydrology Assessment

The Sepaka River which flows from the vast mountains of the southwestern part of Daguma Range passing to the waterways in the Upper Sepaka is a tributary to the Allah River in Surallah.

Based on the flow data, the minimum monthly flow would be around 2cms/sec. This could be the design flow for this micro hydro in Barangay Upper Sepaka. At this site, the calculated drop in height is 4.54 meters from the proposed forebay tank to the powerhouse. This gives an initial estimate of 40 kilowatts. The selection of load centers for demand survey was a decision of the YAMOG technical team and the community in the said barangay. The selection of potential source of streams and sites for survey was primarily a decision taken by the villagers. Site for detail survey was finalized with technical and cost considerations put forth by the Technical Team. The technical team provided suggestions in terms of selection criteria such as electricity demand & site potential required, stability of locations for construction, cost implications etc. Likely costs flow and head required to meet the likely demand were also explained and taken into account while selecting the site.

VIII. TECHNICAL DESIGN AND SPECIFICATIONS DESCRIPTION

Civil Works

During the process of designing the civil works aim has been to keep the civil works costs as low as possible at places where there is possibility of recurring damage due to flood for instance and at the same time have simple and robust construction at other places to keep the maintenance cost low. Adequate attention has been paid to utilize locally available material and resources to the extent possible. (*Please see drawings and bill of quantities for details of construction and specifications*).

Head Works

A diversion of RCC Pre cast and rubble masonry of 1.20 in width at the bottom and 1m in height at the top and 24 meters long will be constructed along the creek so as to divert the required river flow towards gravel trap and de-sanding basin at all times. This structure is constructed temporarily so that when flood comes and pre cast RCC will be washed out, it is easy to re-install using the equipment that are available at the LGU of Surallah. This design were made because of the cost, if permanent diversion will be constructed on a 24 meters wide river, the whole cost of the proposed MHP would be high.

A submerged intake orifice in the form of a sluice gate is provided to reduce the flow when the river / stream are in flood. A course trash-rack of 1.90 m x 0.60 m clear spaced at 0.05m is installed at the intake to keep large floating debris and gravel from entering the headrace. The sluice gate can be completely closed when there is need of any maintenance work downstream. Flood retaining wing wall height is 4 meters from the river bed to the top of the wing wall provided to protect head works during high flood level. A 12 meters gravel trap is provided immediately downstream from the intake with facility to spill out excess water and a pipe flushing device to flush out gravels. The construction works apart from the weir, which is prone to damage during flood, are proposed to be concrete. The debris collected upstream of the weir / intake during high flow seasons will have to be cleared manually.

Headrace Canal

A short Rubble masonry canal of about 1.9 m width x 1.9 m in height and 123 meters in length conveys water from the intake. The remaining 552 meters is earth canal. A wooden stop log was provided at the mouth of the canal to stop the flow from the gravel trap to the settling basin during periodic and regular maintenance of the canal.

Gravel Trap

A rubble masonry of 2.7 meters width and 1.9 meters high and 12 meters in length is constructed right after the intake to collect 50 mm of gravel from the intake in case it enters the canal during rainy season or during flood. Gravel collected will be flushed through a six (6) inches pipe.

Forebay

A 3.1 m x 4 m and 16.7 meters in length, 6 inches CHB steel reinforced and fine finished walling forebay has been provided at the end of the earth canal and at the start of penstock. The tank serves the purpose of water cushion for absorbing the velocity of water exiting from the headrace conduit and also as a penstock inlet chamber. A fine trash rack with a dimension of 4 m x 2.4 m and 5mm clear space has been provided to keep floating debris from entering the penstock. A spillway leads excess water down to a safe place and a 6 inches pipe spillway cum flushing facilitates occasional flushing/ draining needs. The penstock entrance will be submerged 1.85 meters enough to avoid vortices.

Penstock Pipe

A 1.0m Ø x 0.01 m pressure rolled welded pipe with a total length of about 20 m is selected to convey water from forebay to the powerhouse. The whole length of the pipe will be elevated to avoid corrosion. The pipes can come in sections and it is easy to join using mild steel flange couplings and some sections will be welded at site and with saddle support and anchor blocks at the forebay tank at the bend and in the powerhouse. Expansion joints will be installed every after the anchor blocks for easy repair when part of the penstock is damage. .

The lower end of the penstock is to have a flange connection facility to match the flange of the main inlet valve.

Anchor Blocks and Expansion Joints

A Trapezoidal anchor blocks with a top width of 1.5 m x 2.0 m bottom width and 1.5 m in height. It is constructed by RCC since this will protect the penstock in case of contraction and movement due to water hammering during the operation. There are three unit of anchor blocks will be constructed.
Three units of expansion joints will be installed near the anchor blocks. These expansion joints will be placed inside a small manhole like structure for future repair and maintenance. Construction of a manhole like structure should

have allowance for free movement of the penstock. Two units of saddle support will be constructed in between anchor to prevent the penstock from sagging. It is a trapezoidal structure with a top width of 1.5 m x 2.0 m bottom width and 1.5 m in height.

Powerhouse

The concrete powerhouse (4m x 5m outside floor area) is 2 meters well above the flood water level of the stream. The powerhouse roofing is proposed to be GI sheets. The exact size of the powerhouse, machine foundation and tailrace layout should be finalized after finalizing the equipment. All metal structures of the powerhouse are proposed to be grounded along with generator neutral forming equi-potential bondage to minimize risks of lightning. (*Final dimension and requirements for the powerhouse will be given by the equipment supplier).*

Tailrace

A 1 m x 1.1 m reinforced CHB (4x8x16) canal is constructed from the turbine tail water to convey water back to the river. A 1 m X 1.1 m gabion box is attached to the tailrace end to protect the tailrace bank from scouring and erosion. A total length of about 35 meters would be constructed to the point where the water drains back to the Sepaka River.

Generating Equipment

The requirements and possible alternatives for the equipment are briefly specified under the equipment heading of 'Summary of Technical Specifications' at the beginning of the report. In brief the equipment shall be robust and designed to operate manually by under skilled operators in remote area. The equipment is to run in isolation. The design parameters are:

Gross head – 4.54 m
Design net head – 4.48 m
Design flow – 2,000 lps
Ambient temperature and altitude – 30 deg centigrade and 218 m above sea level
The water contains some lime during high flow season
Load power factor – 0.54 at peak load hours
Required out put – 40 kW from generator
Voltage – 220/380 Vac with neutral point
Frequency – 60 Hz

It is highly recommended that, if possible the whole generating equipment including adapter pipes and valves, otherwise at least the turbine generator group be assembled and tested at shop before delivery to do away with any mis-match that is difficult to rectify at site once it is delivered or installed. It is further recommended that the assembly and testing be inspected by qualified micro-hydro engineer to check if it meets the requirement and specifications. Different manufacturer may offer different turbine and other component, the ultimate requirement being the operating conditions like head and flow for the turbine and load power factor for the generator.

Main Inlet Valve

A 1m ID butterfly valve with manual hand-wheel and gear mechanism is recommended for total flow control and to be installed at the end of the penstock. This valve is meant for operating or shutting down the plant and not for flow regulation. Alternatively, gate valve with hand wheel and pressure equalizing by-pass can be considered. The valve is to be rated for 1.5 times the head including surge.

Pipe Adapters

Mild steel pipe adapters are proposed to connect main inlet valve to the equipment down stream. To facilitate easy installation / maneuvering of equipment installation and maintenance works, the adapter pipe is to be in two sections

connected with expansion joint. The flange details of adapter pipes shall be coordinated with inlet valve flange and the flange at the equipment manifold.

A precision pressure gauge is to be provided for air bleeding valve to facilitate intermittent monitoring of water pressure during plant operation and particularly for testing of the plant and equipment. The pressure gauge is to be fitted to the pipe using a standard nipple. The pressure gauge could be installed either on the adapter pipe or on the turbine manifold as felt convenient by the equipment supplier.

Turbine

The basic requirements / specifications recommended for the turbine are as follows:

a. For the operating head and flow and possibility of in-country fabrication, an Axial Flow Pump As Turbine is recommended for this site.
b. Unless the ultimate turbine supplier has mechanical flow interrupting / closing device, it is recommended that all rotating parts of the turbine be able to withstand runaway speed at least for one hour.

The turbine efficiency required to obtain 40 kW electrical output from generator is about 50%. Locally fabricated AFPAT of local design may be only 50% to 65% efficient. Hence, the project design is based on the assumption that AFPAT locally manufactured will be used in this project since imported turbines are very expensive.

Generator

Given the amount of the power generated, cost of control system and cost transmission line, a three-phase generation is recommended. The continuous capacity of generator recommended hereunder takes into consideration the load characteristics (expected peak load power factor 0.54), starting KVA requirement, ELC type (thyrister type) and future load growth. Minimum generator capacity estimated from demand. Reviewing specifications of commercially available generator generally used for micro-hydro application, the full generator specification is recommended as follows.

Class B insulated rated to supply 60KVA continuous at class F temperature rise, rated power factor 0.8, 3phase 230V, 4pole 1800rpm, IP23 or better, self excited & self regulated synchronous generator equipped with automatic voltage regulator (AVR). It is further recommended that the generator rotor winding be specially braced to withstand runaway speed at least for 1 hour. The generator AVR must be equipped with overload protection feature to protect generator from prolonged overload / short circuit.

Governing

The plant is a run-off-the-river type without any storage pond. The governing system recommended is therefore an Electronic Load Controller (ELC). Reviewing commercially available ELC types and considering the need to coordinate ELC specification with the generator specification (and vice versa), the recommended specification of ELC & its associated gears is as follows.

Frequency sensing type, thyrister controlled 3phase 60 Hz ELC rated to control at least 40 kW resistive ballast load. The ELC board and its associated switchgear and instruments will be installed in the main control panel itself. It is recommended that the resistive ballast load be immersion type water heaters installed in a tail water to ensure that there is enough water to avoid burning of the heaters.

Control Panel

It is recommended to have a free-standing mild steel control panel. All instruments, indicators and breaker levers are to be accessible from the front. The following specifications are recommended for the control panel.

a. Instruments: 1 V-meter, 1 A-meter, 1 Frequency meter, 1 Hour-rum meter
b. Indicators: generator excitation ON indicator (yellow), feeder line ON indicator (red)
c. Feeder breaker: double pole 80A tripping thermal-magnetic breaker, magnetic tripping ~ 250%

d. Powerhouse supply breaker: 20A SP MCB

Transmission and Distribution Line

There are a number of load centers scattered within the project area to be supplied with electricity. The distance from powerhouse to the end of the load centers is relatively far for the amount of power to be transported. Therefore high -tension line is proposed for the main lines. While low tension lines from step down transformer will connect the scattered settlements to the micro-grid. Transmission and distribution line design / specifications are given hereunder. The design and specifications take into account general practice and guidelines adopted for rural and off-grid electrification in the Philippines. Please refer to transmission / distribution line plan and single line representation of transmission / distribution line for more details.

Power Cable Transformers

a. Average user load peak time power factor: 0.54 as per the load demand analysis
b. Cable to connect control panel in powerhouse to step up transformer: 2 core 60 mm2 armored copper PVC cable is recommended. The current rating of the cable is about 1.7 times the full load current at full load KVA
c. Step-up transformer: Capacity enough to supply continuously 40kW at 0.54 user load factor. Recommended size 15KVA, 230V/7.6KV, 60 Hz outdoor type 1phase transformer x 3 units.
d. Step-down transformers: Three locations will have step-down transformer stations from where 230V lines will be distributed. Each of the step-down transformers will be 15KVA, 7.6KV/230V, 60 Hz outdoor type 1phase transformers x 3 units.
e. Cables to connect step-down transformer to LT line pole: 2 core 30 mm2 armored copper PVC cable are recommended. The current rating of the cable is about 1.7 times the full load current at full load KVA to be supplied by the step-down transformers.

Switchgear & Protection

a. For overload and maintenance purpose HT side of step-up transformer & step-down transformers each will have two pole re-wirable drop-out fuse for phase and neutral.
b. Each of the HT transmission line conductors will be grounded through a suitably rated pole mounted HT lightning arrester at the start, at the end and at the intermediate distribution transformer station of the HT line. The voltage rating of lightning arresters should closely match the transmission voltage and the current rating should be minimum 5KA. Grounding will be done through 16 mm2 solid GI conductor and 2.5m long ½" GI ground rod.
c. Each of the LT distribution line conductors will be grounded through a suitably rated pole mounted LT lightning arrester at the start and at the end of the LT line. The voltage rating of lightning arresters should closely match the distribution voltage and the current rating should be minimum 5KA. Grounding will be done through 16 mm2 solid GI conductor and 2.5m long ½" GI ground rod.

Conductors

For HT overhead lines 14mm2 ACSR are recommended. These wires can carry the enough current and not to worry about appreciable voltage and power loss. Also for reasons of cost and simplicity of the MHP system.

For LT overhead distribution lines AAC conductors are recommended. The sizes of the conductors are selected to have a voltage drop at any end of the line is below 10%.

Poles – For reasons of simplicity, cost and local resource utilization, locally available wooden poles are to be used. These poles are to be treated with suitable wood preservative for long life. The recommended poles are to be minimum 8" diameter at top and 10" diameter at bottom with a overall length of minimum 8 meters for high voltage line and 6" diameter at top and 8" diameter bottom with the length of 7 m for low voltage line.

Insulators – For high voltage line – high voltage type pole top pin and pin insulator that is normally used in Philippine standard will be used and Spool type low voltage insulators are recommended to be fitted on the poles in order to carry the conductors at a minimum of 0.60m vertical clearance for high tension line and 0.30m for the distribution lines.

Pole stays – The poles are to be stayed at every bend and at each end with standard pole stays made of GI wire, insulator, and thimble and ground plate with rod. It should be possible to maintain the tightness of the stays in future.

Lightning protection – Each end of the overhead line is to be provided with a set of high voltage lightning arrester. The lightning arresters should be grounded with a metal pipe or rod as per the prevailing standard and practice. The ground connection of the arrester at the pole nearest to the powerhouse should be connected with the powerhouse earthing. Low voltage lightning arresters are also recommended to low voltage line for the protection of the equipment in the powerhouse in case lightning strikes directly the equipment.

Consumer connection

Each household is to be directly connected to single phase supply at the nearest distribution pole through service drop PVC cable. All industrial and commercial consumers are to be connected through adequate size of conductor.

IX. PROJECT COSTS, INCOME AND FINANCIAL ANALYSIS

The completed feasibility study shows that there are enough financial justifications of the proposed MHP project in Bgy Upper Sepaka. With the assumption that the total project cost will be available for the project (with active participation from the community members during the construction phase) to complete the project, the computed energy cost is quite low to be recommended for a community-based development project. With the community's capability to pay, they could afford to pay for the electricity that will be produced by the micro-hydropower. The productive end-uses would contribute to the sustainability of the project.

The computation for the financial analysis (NPV) takes into account the cost and the revenue for the household lighting, refrigeration and small household appliances and the end-uses like the bakery costs and the projected annual revenue is not taken into consideration in computing for the NPV. The NPV is positive at 12%. Please see Annex on Income and Financial Analysis.

X. SOCIO – ECONOMIC AND ENVIRONMENTAL ASPECTS

1. Socio-economic Aspects

The socio-economic livelihood activities and other productive end-uses would ensure active participation from beneficiary to keep the plant running. Any electrification project without sustainable livelihood component would give a less chance of the project to be sustainable. At least the following intangible benefits may be counted in.

Potential Benefit on Education: The quality and availability of household lighting is expected to improve with MHP electrification. Hence, study periods and study habits are expected to increase and improve, respectively. Furthermore, school lighting and the use of electricity driven equipment (e.g. computers) are expected to also improve significantly.

Convenience: During nighttime, it is expected that it will be more convenient for the community to perform chores with brighter illumination. Similarly school children need not use kerosene lamps during studying which is dim and unhealthy.

Communication: Mass communication including radio and television / video has become the back bone of social awareness and development. The project will make access for communication, news and entertainment. With the use of transistor radios and television, they would further have access to outside world.

Economic activities: With the possibility of local processing of grains and longer working hours with brighter lights (unlimited as compared to kerosene), development of micro-hydropower with productive end –uses would ensure the economic upliftment and sustainability of the project.

Health: The improved quality of light as compared to kerosene wick lamps will improve health condition, especially with regard to the eyes and smoke.

2. Environmental Aspects

Vegetation surrounding the source of water in the watershed area is filled with a very few secondary growth dipterocarp forest ecosystem. A limited species of hardwood trees were noted in the remaining watershed area. There seems to be a practice of slash and burn that affects the local environment. Further more, it is observed that there are significant areas that are prone to landslips/landslides. So there is a need for a long-term plan for watershed protection and maintenance. There is need for a long-term plan to ensure environmental protection. The vegetation in the area needs to be improved firstly for ensuring perennial flow for the micro-hydro secondly for protecting against landslides and also for improving biological ecosystem. There is no negative environmental effect resulting from the micro-hydro project.

For the natural resource management component to sustain apart from being a community-based, it should anchor on the barangay development plan where barangay and even the municipality can provide policy and implementation regulation in terms of environmental protection and watershed rehabilitation and management.

Linkages with the government-line agencies should be enhanced and strengthened.

XI. RECOMMENDED TARIFF STRUCTURE

Thus aspect of the study elucidates the consumers/beneficiaries capacity to pay for the services at the computed unit energy cost

Household Electrification

Capacity to Pay

The population of the Barangay Upper Sepaka belongs to the poor sector of the rural population in the region. However, family income is regular and dependable as they are growing corn and other products and others have income generating activities like sari-sari store. The bulk of their expenses go to food, education and energy. Food has been sufficient the whole year round. Although during long dry season, food would be inadequate and they are then planting root crops such as camote (sweet potatoes) and other root crops for subsistence. Based on the survey conducted an average of PhP 80.00 to 100.00 is the current energy usage and given the opportunity to have quality lighting most of them are willing to pay more than they are paying currently for their energy use.

Tariff System /Willingness to Pay

Upper Sepaka BAPA which is the community based organization will sell electricity to the households at a much affordable rate, and yet will still generate funds for the maintenance of the project. Other sustainable livelihood projects like Bakery and Refrigeration, and other socio-economic projects would also ensure socio-economic activities in the community towards economic uplift of the community members. The majority of the population would want a 4- compact fluorescent lamps at 9-11 watts per lamp tube for lighting.

Recommended Tariff

Based on the calculations (Annex on Annual Energy supply and Costs) the recommended tariff is as follows:

Household lighting (including street lighting and lighting at schools and mosques) = P **5.59**/watt/mo

Refrigeration	**=**	**PhP14.34**
Battery Charging	**=**	**PhP 40.86**
Bakery	**=**	**PhP 34.52**
Rice mill	**=**	**PhP 49.48**

XII. RECOMMENDATION ON CONSTRUCTION AND OPERATION

Trainings and Management

The Barangay Upper Sepaka BAPA is organized to work together in the whole process of project implementation and to eventually manage the plant after the construction is completed and handed over to them. Proper selection of BAPA members, introducing and enforcing guidelines for operation of the BAPA and electricity rules will help sustain the project. The BAPA formed to manage the micro-hydropower project is composed of active leaders of the community. All household beneficiaries are BAPA members and act as the General Assembly.

Local operators are identified by the community which would undergo on- the- job training and non-formal training courses on basic electricity, household wiring installation, mechanical work and other related training courses (through TESDA accredited training institutions like academe).

Furthermore, financial management and other capability building trainings would be conducted to enhance the management capability of the leaders. Enterprise development training would also be conducted to enhance the skills and capacity of the leaders on entrepreneurial development. These capability studies would be done during the construction phase and a follow-up trainings be done during the actual operation and post project implementation aspects towards projects sustainability.

Organizational / Social Aspect

Well thought out plan for social preparations should be developed with maximum participation of the community members with the barangay officials and respected community leaders.
Organizational development (through BAPA) needs to be addressed in order for it to be capable to manage and sustain the micro-hydropower project and other socio-economic and sustainable livelihood projects using the available power from the micro hydro. Continuing community capability building (such as financial management, bookkeeping and other technical trainings) is important to be given priority attention to enable the leaders and members with the upgraded knowledge and skills in the successful management of their community-based micro hydropower project and community-initiated development projects. The community is capable and willing to pay for the energy premiums. Community mobilization should be enhanced to promote active participation in installation and post-installation phase of the project.

Management Capacity to handle community development projects.

To prepare the community to implement micro hydro power project, it might help if they can demonstrate their community capacity or the barangay to undertake other community development projects like potable water system which is already completed in partnership with other NGO's. The experience that the community would gain from this experience would be a necessary and community learning experience for them to undertake a much bigger challenge of renewable energy and natural resource a management.

Role of Community / BAPA:

Community mobilization for participation in the pre- construction, actual construction through voluntary labor in hauling of sand, gravel and other construction materials, taking care of equipment and materials brought in the area in their custody, etc. and other community participation in terms of house wiring and other community initiated

projects / post-installation like the watershed management and protection activities to promote local environmental initiatives. Food for work is however, recommended. Identified local operators and leaders would be trained.

Role of GENTUD Foundation, Inc.:

As such, because of their long experience in working with the community, it has the capacity to act as one of the proponents, as the lead implementing organization with the main role of ensuring the community preparations and community organizing so that active participation of the project is always enhanced. This would enhance greater sense of community ownership as a community initiated, community-managed, and community-owned micro hydropower project. It would facilitate skills capability building training among the leaders and members to equip them with knowledge and skills in managing their project.

Role of YAMOG:

Being the party responsible for technical feasibility study, YAMOG could best provide services for technical supervision and coordination during the pre-construction, construction and post-construction periods including assisting the community with pre-construction activities, assisting and monitoring works at site, train local leaders and operators, post-installation monitoring & evaluation work, etc.

XIII. ANNEXES

ANNEX 1: MAPS

BOHOL
Central Visayas
Bohol Sea
Northern
Mindanao
Caraga
MINDANAO
Davao
Region
Region
Mindanao
Soccsksargen
Tagbilaran
Dumaguete
Siquijor
Camiguin
Mambajao
BUTUAN
Gingoog
CAGAYAN DE ORO
Oroquieta
Ozamiz
ILIGAN
Marawi
Dapitan
Dipolog
Pagadian
Malaybalay
Valencia
Maramag
Dangcagan
Kibawe
Tandag
Bislig
Bayugan
Prosperidad
San Francisco
TAGUM
Panabo
DAVAO CITY
MATI
Sta. Cruz
Digos
Malita
Sultan Kudarat
COTABATO CITY
Midsayap
Pikit
Kidapawan
M'lang
Tacurong
Isulan
Koronadal
Norala
Surallah
Banga
Tupi
Polomolok
T'Boli
GENERAL SANTOS
Malabang
Parang
Balabagan
Maitum
Kiamba
Maasim
Glan
Jose Abad Santos
Mt. Apo
Davao Gulf
Sarangani Island

ANNEX 2: TECHNICAL DRAWINGS (CIVIL, ELECTRICAL)

ANNEX 3: PHOTOGRAPHS

ANNEX 4: DISCHARGE MEASUREMENT

Location: Brgy. Upper Sepaka, Surallah, South Cotabato
Date: June 16, 2006
Weather: Clear but rain falls a day before the measurement
Instrument: Current flow meter
Source: Sepaka River

Trials	**Depth(m)**	**width(m)**	Velocity in m/s							
			V_1	**V_2**	**V_3**	**V_4**	**V_5**	**V_{AVE}**	**fv**	**Q(m3/s)**
1	0	0	0	0	0	0	0	0	0	0
2	0.27	1	0.45	0.64	0.49	0.46	0.49	0.506	0.06831	0.034155
3	0.35	1	0.52	0.64	0.56	0.64	0.66	0.604	0.19425	0.13128
4	0.35	1	0.74	0.69	0.64	0.63	0.65	0.67	0.22295	0.2086
5	0.48	1	0.68	0.73	0.72	0.7	0.76	0.718	0.33312	0.278035
6	0.50	1	0.71	0.69	0.75	0.72	0.71	0.716	0.3585	0.34581
7	0.44	1	0.84	0.86	0.81	0.85	0.85	0.842	0.34276	0.35063
8	0.48	1	0.7	0.69	0.67	0.71	0.73	0.7	0.37008	0.35642
9	0.53	1	0.72	0.71	0.73	0.71	0.74	0.722	0.37683	0.373455
10	0.60	1	0.65	0.69	0.69	0.66	0.65	0.668	0.417	0.396915
11	0.68	1	0.63	0.68	0.69	0.65	0.64	0.658	0.45084	0.43392
12	0.63	1	0.66	0.67	0.64	0.69	0.62	0.656	0.41391	0.432375
13	0.62	1	0.63	0.64	0.57	0.59	0.59	0.604	0.3906	0.402255
14	0.60	1	0.65	0.61	0.65	0.63	0.68	0.644	0.3744	0.3825
15	0.50	1	0.47	0.53	0.54	0.55	0.53	0.524	0.292	0.3332
16	0.38	1	0.23	0.21	0.24	0.26	0.21	0.23	0.14326	0.21763
Total		**15m**								**4.67718**

ANNEX 5: ENERGY DEMAND / LOAD MANAGEMENT ANALYSIS

Load			
1. Lighting load	Average daily loading factor	70	%
	Domestic	22995	kWh
	Church	153.3	kWh
	El school	327.04	kWh
	St lighting	2207.52	kWh
	Subtotal	25683	kWh
	Plant availability	95	%
	Probable kWh to be sold for lighting	24399	kWh
2. Grains grinder	Population	100	
	Annual consumption of rice	2000	kg
	Grinder capacity	25	kg/hr
	Grinder operating hours/annum	80	hrs
	Average operation/day	2.0	hrs/day
	kWh consumed/annum	200	kWh/yr
3. Rice Mill	Population	1000	
	Annual consumption of rice	109500	kg
	Huller capacity	200	kg/hr
	Operating hours/annum	548	hrs
	Average operation/day	2	hrs/day
	kWh consumed/annum	4380	kWh/yr
4. Battery charging	Households targetted	100	hh
	Lighting requirement	20	watts
	Lighting hrs per day	4	hrs
	Total Wh per day	8000	Wh
	Energy to be sold per annum	3650	kWh
	Battery size	70	Ah
	Re-charging at	50	%
	Usable Wh of each battery	420	Wh
	Selling Wh for each battery	525	
	Re-charging duration	6	hrs
	Minimum charger capacity per battery	70	VA
	Charging frequency	5.25	days
	Average number of batteries charged per day	19	Batteries
	Available charging hours	11	
	Average batteries being charged any time	10	
	Total charger capacity required	1333.3	VA
	Revised charged capacity	2000	VA
5. Bakery	Population	500	
	Annual consumption of flour	10000	kg

	Mixer / Roller Capacity		10	kg/hr
	Mixer operating hrs/annum		1460	hrs
	Average operation/day		4	hrs/day
	kWh consumed/annum		3650	KWh
6. Other end-usesEntertainment,refrigeration,etc	Estimated kWh		6205	kWh
Total kWh to be supplied			42484	kWh
Installed capacity of plant, kW		26.7	70080	kWh
Load factor			61	%

ANNEX 6: FINANCIAL ANALYSIS

O and M costs

Annual operating costs:					
Operators - 3 pax @ P3000/mo		P/yr	108,000.00		
Manager - 1 pax @ P2000/mo		P/yr	24,000.00		
Administrative expenses(Supplies, Comm,etc)	1.00%	P/yr	41,976.11		
Maintenance of MHP	2.00%	P/yr	83,952.23		
Interest on loan	0.00%	P/yr	0.00		
Subtotal annual operating costs			257,928.34		
Depreciation provision at inflation rate of	4.00%	P/yr	210,763.18	20	Yrs
Total annual costs			468,691.52		

Energy Production cost

Total kWh sold		kWh	42,484
Cost / kWh (with full depreciation)		P/Kwh	11.03
Cost / kWh (with no depreciation)		P/Kwh	6.07

Estimate of load factor

Plant size	kW	35.00	35.00
Load factor	%	12.76%	17.49%
Plant factor at 95% availability	%	13.43%	18.41%

Tariffing basis and Minimum Recommended Tariffs

Household lighting connection within distribution area:					
Generation cost	100.00%	P/kWh	11.03		
Community development fund	30.00%	P/kWh	3.31		
Selling cost		P/kWh	14.34		
Equivalent flat rate for 13 hrs a day connection		P/w/mo	5.59		
Rice Mill:					
Generation cost	100.00%	P/kWh	11.03		
m/c maintenance	10.00%	P/kWh	6.85		
m/c depreciation at inflation of	4.00%	P/kWh	15.39	5	Yrs
Building maintenance (80% of total area)	5.00%	P/kWh	1.71		
Building depreciation (80% of total area) at	4.00%	P/kWh	3.08	15	Yrs
Community development fund	30.00%	P/kWh	11.42		
Selling cost of energy for corn mill		P/kWh	49.48		
Corn processed per kWh		KG/kWh	25.00		
Processing cost per kG of rice		P/KG	1.98		
Grains Grinder					
Generation Cost	100.00%	P/kWh	11.03		
Grinder Maintenance	10.00%	P/kWh	20.00		
Grinder depreciation at inflation of	4.00%	P/kWh	44.93	5	Yrs
Building maintenance (20% of total area)	5.00%	P/kWh	5.00		
Building depreciation (20% of total area) at	4.00%	P/kWh	8.99	15	Yrs
Community development fund	30.00%	P/kWh	26.99		
Selling Cost of energy for Grains Grinder		P/kWh	116.94		
Grain processed per KWh		KG/kWh	10.00		

Processing Cost per KG of Grains		P/KG	11.69		
Bakery:					
Generation Cost	100.00%	P/kWh	11.03		
Mixer Maintenance	10.00%	P/kWh	3.70		
Mixer depreciation at inflation of	4.00%	P/kWh	8.31	5	Yrs
Building maintenance (20% of total area)	5.00%	P/kWh	1.85		
Building depreciation (20% of total area) at	4.00%	P/kWh	1.66	15	Yrs
Community development fund	30.00%	P/kWh	7.97		
Selling Cost of energy for bakery		P/kWh	34.52		
Flour processed per KWh		KG/kWh	2.74		
Processing Cost per KG of flour		P/KG	12.60		
Battery charging connection:					
Generation cost	100.00%	P/kWh	11.03		
Charger maintenance	10.00%	P/kWh	0.96		
Charger depreciation at inflation of	4.00%	P/kWh	3.46	3	Yrs
Building maintenance (20% of total area)	5.00%	P/kWh	0.10		
Building depreciation (20% of total area) at	4.00%	P/kWh	0.17	15	Yrs
Community development fund	30.00%	P/kWh	4.71		
Selling cost of energy for battery charging		P/kWh	20.43		
Charging cost per battery at flat rate		P/Bat	40.86		
Other enduses like private coffee grinder, ice candy factory, TV/video:					
Generation cost	100.00%	P/kWh	11.03		
Community development fund	30.00%	P/kWh	3.31		
Energy selling cost		P/kWh	14.34		

ANNEX 7: INCOME and FINANCIAL ANALYSIS

Estimated Annual Revenue:		
Household Lighting		349,881.66
Rice mill		216,810.00
Grains grinder		23,388.00
Battery Charging		74,569.50
Bakery		127,209.80
Other End-uses (refrigeration,entertainment)		88,979.70
Total Annual Revenue	**P**	**880,838.66**
Total Annual Operating Cost	**P**	**468,691.52**

Year	A. Expenditure	B. Revenue	C. Annual Net Earnings (B-A)	D. Discount Factor (12%)	E. Annual Present Value, CxD
0	468,691.52	-	468,691.52	1.00	(468,691.52)
1	478,065.35	880,838.66	402,773.31	0.89	359,636.29
2	487,626.66	880,838.66	393,212.00	0.80	313,468.61
3	516,884.26	880,838.66	363,954.40	0.71	258,407.63
4	547,897.31	880,838.66	332,941.35	0.64	211,584.23
5	580,771.15	880,838.66	300,067.51	0.567	170,258.30
6	615,617.42	880,838.66	265,221.24	0.506	134,201.95
7	652,554.47	880,838.66	228,284.19	0.452	103,252.94
8	691,707.73	880,838.66	189,130.93	0.404	76,389.98
9	733,210.20	880,838.66	147,628.46	0.361	53,234.82
10	777,202.81	880,838.66	103,635.85	0.322	33,370.74
11	823,834.98	880,838.66	57,003.68	0.288	16,388.56
12	873,265.08	880,838.66	7,573.58	0.257	1,944.14
13	925,660.98	880,838.66	(44,822.32)	0.229	(10,273.28)
14	981,200.64	880,838.66	(100,361.98)	0.205	(20,534.06)
15	1,040,072.68	880,838.66	(159,234.02)	0.183	(29,092.06)
				NPV (12%)	**1,203,547.28**

ANNEX 8 - A: BILL of QUANTITIES – CIVIL WORKS & COST

Items		Quantity	Unit	Rate	Total
Final Engineering & Design					
Civil Works					
A	**Preparatory works**				
B	**Weir / Dam**				
1	**Gabion Box (1.2mx1.2mx1.2m)**				
	Boulders	*17.5*	*cu m*	*330.00*	*5,775.00*
	6', #10 cyclone wire	9	rolls	750.00	6,750.00
	10mmØx6m rsb	27	length	130.90	3,534.30
	#16 tie wire	4	kgs	67.00	268.00
2	**Pre-Cast**				
	Earth excavation	*8*	*cu m*	*284.28*	*2,274.24*
	Sand	*14*	*cu m*	*330.00*	*4,620.00*
	Gravel	*27*	*cu m*	*330.00*	*8,910.00*
	Cement	225	bags	243.50	54,787.50
	10mmØx6m rsb	66	length	130.90	8,639.40
	16mmØx6m rsb	35	length	327.80	11,473.00
	25mmØx6m rsb	2	length	783.20	1,566.40
	1/4" plywood	30	sheet	385.00	11,550.00
	150 - 2x2x8 cocolumber	400	bd ft	13.50	5,400.00
	Assorted nails	5	kgs	53.80	269.00
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of B				**155,816.84**
C	**Headwall & Wingwall**				
	Earth excavation	*29*	*cu m*	*284.28*	*8,244.12*
	Gravel base	*2*	*cu m*	*330.00*	*660.00*
	Sand	*11*	*cu m*	*330.00*	*3,630.00*
	Gravel	*22*	*cu m*	*330.00*	*7,260.00*
	Cement	180	bags	243.50	43,830.00
	12mmØx6m rsb	96	length	178.20	17,107.20
	10mmØx6m rsb	99	length	130.90	12,959.10
	#16 tie wire	12	kgs	67.00	804.00
	1/4" plywood	49	sheet	385.00	18,865.00
	245 - 2x2x8 cocolumber	653	bd ft	13.50	8,820.00
	Assorted nails	7	kgs	53.80	376.60
	Intake thrashrack	1	set	4,000.00	4,000.00
	Intake sluice gate	2	set	8,000.00	16,000.00
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of C				**172,556.02**
D	**Gravel Trap**				
	Excavation	*66*	*cu m*	*284.28*	*18,762.48*
	Gravel base	*6*	*cu m*	*330.00*	*1,980.00*
	Sand	*6*	*cu m*	*330.00*	*1,980.00*
	Gravel	*12*	*cu m*	*330.00*	*3,960.00*
	Cement	110	bags	243.50	26,785.00
	10mmØx6m rsb (vertical & horizontal bars)	212	length	130.90	27,750.80

	#16 tie wire	11	kgs	67.00	737.00
	1/4" plywood	52	sheet	385.00	20,020.00
	240 - 2x2x8 cocolumber	640	bd ft	13.50	8,640.00
	Assorted nails	7	kgs	53.80	376.60
	6"Ø GI flushing pipe	1	set	3,000.00	3,000.00
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of D				**143,991.88**
E	**Powerhouse (4x5m)**				
	Earth excavation	*3*	*cu m*	*284.28*	*852.84*
	Compacted gravel base	*3*	*cu m*	*330.00*	*990.00*
	4x8x16 CHB	820	pcs	9.50	7,790.00
	Cement	88	bags	243.50	21,428.00
	Sand	*7*	*cu m*	*330.00*	*2,310.00*
	Gravel	*5*	*cu m*	*330.00*	*1,650.00*
	8mmØx6m rsb	47	length	79.00	3,713.00
	10mmØx6m rsb	60	length	130.90	7,854.00
	#16 tie wire	9	kgs	67.00	603.00
	1/4" plywood	10	sheet	385.00	3,850.00
	50 - 2x2x8 cocolumber	133	bd ft	13.50	1,795.50
	Corr GI sheets (10' long)	22	sheet	439.00	9,658.00
	Plain GI sheets	2	sheet	387.40	774.80
	Umbrella nails	5	kgs	85.80	429.00
	Good lumber (for woodworks)	530	bd ft	30.50	16,165.00
	Assorted nails	7	kgs	53.80	376.60
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of E				**110,239.74**
F	**Tailrace**				
	Earth excavation	*60*	*cu m*	*284.28*	*17,056.80*
	Compacted gravel base	*5*	*cu m*	*330.00*	*1,650.00*
	4x8x16 CHB	1251	pcs	9.50	11,884.50
	Cement	100	bags	243.50	24,350.00
	Sand	*9*	*cu m*	*330.00*	*2,970.00*
	Gravel	*6*	*cu m*	*330.00*	*1,980.00*
	8mmØx6m rsb	67	length	79.00	5,293.00
	10mmØx6m rsb	60	length	130.90	7,854.00
	#16 tie wire	6	kgs	67.00	402.00
	Labor cost (skilled worker)	80	man days	250.00	20,000.00
	Total of F				**93,440.30**
G	**Anchor Blocks (3 units)**				
	Cement	50	bags	243.50	12,175.00
	Sand	*3*	*cu m*	*330.00*	*990.00*
	Gravel	*6*	*cu m*	*330.00*	*1,980.00*
	10mmØx6m rsb	49	length	130.90	6,414.10
	#16 tie wire	4	kgs	67.00	268.00
	77 - 2x2x8 cocolumber	205	bd ft	13.50	2,767.55
	Assorted nails	4	kgs	53.80	215.20
	Labor cost (skilled worker)	40	man days	250.00	10,000.00
	Total of G				**34,809.85**

H	**Saddle Support (2 units)**				
	Cement	35	bags	243.50	8,522.50
	Sand	*2*	*cu m*	*330.00*	*660.00*
	Gravel	*4*	*cu m*	*330.00*	*1,320.00*
	10mmØx6m rsb	17	length	130.90	2,225.30
	#16 tie wire	2	kgs	67.00	134.00
	1/4" plywood	6	sheet	385.00	2,310.00
	33 - 2x2x8 cocolumber	88	bd ft	13.50	1,188.00
	Assorted nails	2	kgs	53.80	107.60
	1/4"thick x 2" flat bar	2	pcs	365.40	730.80
	3/4"thick x 2" stainless bolt	4	pcs	95.85	383.40
	Labor cost (skilled worker)	40	man days	250.00	10,000.00
	Total of H				**27,581.60**
I	**Stone Masonry / Riprap Headrace (123 meters)**				
	Excavation	*405*	*cu m*	*284.28*	*115,133.40*
	Sand	*64*	*cu m*	*330.00*	*21,120.00*
	Cement	508	bags	243.50	123,698.00
	Stone / boulders	*127*	*cu m*	*330.00*	*41,910.00*
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of I				**331,861.40**
J	**Earth Canal (552 meters)**				
	Excavation	*2193*	*cu m*	*284.28*	*623,426.04*
	Total of J				**623,426.04**
K	**Forebay Tank**				
	Excavation	*250*	*cu m*	*284.28*	*71,070.00*
	Gravel base	*8*	*cu m*	*330.00*	*2,640.00*
	Sand	*24*	*cu m*	*330.00*	*7,920.00*
	Gravel	*18*	*cu m*	*330.00*	*5,940.00*
	Cement	289	bags	243.50	70,371.50
	6" CHB	1850	pcs	11.50	21,275.00
	Sahara cement	146	kgs	32.30	4,715.80
	12mmØx6m rsb	250	length	178.20	44,550.00
	10mmØx6m rsb	115	length	130.90	15,053.50
	#16 tie wire	16	kgs	67.00	1,072.00
	for spillway canal (riprap)				
	Sand	*26.3*	*cu m*	*330.00*	*8,679.00*
	Stone/boulder	*53*	*cu m*	*330.00*	*17,490.00*
	Cement	212	bags	243.50	51,622.00
	Thrashrack	1	set	20,000.00	20,000.00
	6"Ø GI flushing pipe	1	set	3,000.00	3,000.00
	2"Ø GI breather pipe	2	set	800.00	1,600.00
	Labor cost (skilled worker)	120	man days	250.00	30,000.00
	Total of K				**376,998.80**
	Total for Civil Works				**2,070,722.47**

Note: ***Excavation works, Boulders, Sand & Gravel and Transportation of Materials are proposed to be a counterpart from LGU Surallah. Fuel will be provided by the project.***

ANNEX 8 – B: GENERATING EQUIPMENT

Generating Equipment	Qty	Unit	Unit Rate	Cost
1) Expansion joint and adapter pipes	3	set	15,000.00	45,000.00
2) Gear type butterfly valve 24"Ø	2	set	10,000.00	20,000.00
3) Propeller Turbine (AFPAT)	2	units	415,650.00	831,300.00
4) Synchronous generator, 4 wires, 3 phase 220/380volts, 1800 rpm, 30 KVA, 60 herts, China generator	2	units	40,000.00	80,000.00
5) 3 phase ELC and dummy load, control and switch gear panel	2	set	85,000.00	170,000.00
6) Powerhouse cabling, wiring and earthing	1	lot	10,000.00	10,000.00
7) Handling, installation, testing and commissioning	1	ls	75,000.00	75,000.00
	Total for Generating Equipment			**1,231,300.00**

ANNEX 8 – C: TRANSMISSION & DISTRIBUTION LINES

Item no.	Particulars	Qty	Unit	Unit Price	Amount
	Primary Line Accessories				
1	8 m locally treated wooden poles (8in.Ø top; 10in.Ø butt)	28	unit	800.00	22,400.00
2	14 mm² ACSR	5,500	m	24.15	132,825.00
3	pin type insulator	64	pc	212.75	13,616.00
4	pole top pin	22	pc	207.00	4,554.00
5	cross arm steel pin	42	pc	299.00	12,558.00
6	cross arm 3½"x4½"x8'	28	pc	300.00	8,400.00
7	suspension insulator	14	set	488.75	6,842.50
8	Dead end clamp	8	pc	603.75	4,830.00
9	5/8"x14" machine bolt w/ nut & washer	24	set	59.80	1,435.20
10	5/8"x12" machine bolt w/ nut & washer	44	set	55.20	2,428.80
11	5/8"x10" machine bolt w/ nut & washer	16	set	51.75	828.00
12	5/8"x9" eye bolt w/ nut & washer	8	set	89.70	717.60
13	1-spool rack	16	pc	212.75	3,404.00
14	1¾"Ø groove spool insulator	16	pc	41.40	662.40
15	Wood brace (¾"x2"x3')	44	pc	200.00	8,800.00
16	1/2"x4" Lag screw	21	pc	20.70	434.70
17	1/2"x6" Lag screw	84	pc	20.70	1,738.80
18	3/8"x5" Carriage bolt w/ nut & washer	48	pc	18.98	910.80
19	3.5 mm² Aluminum cond. (bare)	120	m	12.65	1,518.00
	Secondary Line Accessories				
20	6 m Locally treated wooden poles (6in.Ø top; 8in.Ø butt)	24	unit	600.00	14,400.00
21	14 mm² ACSR	1,500	m	24.15	36,225.00
22	14 mm² AAC (insulated)	2,000	m	30.48	60,950.00
23	2-spool rack	38	pc	212.75	8,084.50
24	1¾"Ø groove spool insulator	76	pc	41.40	3,146.40
25	5/8"x4" Lag screw	76	pc	20.70	1,573.20
26	1/2"x6" Lag screw	76	pc	20.70	1,573.20
27	2.0 mm² THW copper conductor (service drop)	70	roll	3,372.38	236,066.25
28	CCA chemical for pole treatment	1	drum	25,000.00	25,000.00
	Transformer and accessories				
29	15 kVA 240V/7.6kV 60Hz 1Ø Dist. Transformer	6	set	34,155.00	204,930.00
30	Open-type dist. Fuse Cut-out w/ 2A fuse link	6	set	4,830.00	28,980.00
31	9 kV Lightning arrester	6	set	3,220.00	19,320.00
32	Transformer pad	1	lot	3,000.00	3,000.00
	Guy accessories				
33	3/8" Guy wire	120	m	21.28	2,553.00
34	Pre-formed guy grip	10	pc	287.50	2,875.00
35	3 bolts clamp	10	pc	300.00	3,000.00
36	Anchor rod w/ nut	10	pc	488.75	4,887.50
37	Square washer (4"x4")	10	pc	126.50	1,265.00
38	Anchor log (8"Øx4')	10	pc	1,092.50	10,925.00
	Grounding accessories				
39	14 mm² ACSR	400	m	24.15	9,660.00
40	U nails	800	pc	5.75	4,600.00

41	Grounding rod (1/2"x10')	10	length	672.75	6,727.50
42	Grounding clamp (1/2")	26	pc	74.75	1,943.50
		Total Cost		**895,588.85**	