Detailed Feasibility Study Report
Of
Odare Marbu Micro Hydro Project
(40 kW)
Bhakanje VDC, Solukhumbu District

Submitted to:

RESOURCE MANAGEMENT AND RURAL EMPOWERMENT CENTER (REMREC)

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SALIENT FEATURE

General

Source of River	:	Odare Khola
Location	:	Bhakanje VDC, Solukhumbu
Altitude	:	2129 m (Power house Elevation)
Ward no	:	1, 2, 3, 5, 6, 7 and 8
Road head	:	
Name	:	Jiri (Araniko Rajmarga)
Distance (Km)	:	75 km
Beneficiary Households (Nos)	:	398
Load Center	:	1, 2, 3, 5, 6, 7 and 8 of Bhakanje VDC of Solukhumbu

Coordinate of:

Intake	:	X: 27'36" N, Y: 86'28" E, Z: 2183m

Technical Parameters

Gross Head	:	51.47 m
Net Head	:	49 m
Measured Flow & Date	:	216 Lps, 13th May, 2009 (Salt Dilution Method)
Least Flow	:	125.94Lps in April
Design discharge	:	139.0 Lps
Overall efficiency	:	57 %
Power Output	:	40 kW
Length of Power Canal	:	280 m (Stone Masonry in 1:4 C/S and Plaster in inner side 1:4 C/S)
Power House	:	Internal dimension (5 x 4 x 2.5, m) for machine room and (3 x 2.5 x 2.5, m) for operator room Stone masonry with mud mortar
Type of Turbine	:	Cross flow, 960 RPM, 54 kW shaft output
Type of Generator	:	83 kVA, 3 Phases, Synchronous, Brushless 400V, 50 Hz, 1500 RPM with AVR
Type of Load Controller	:	ELC 40 kW with Ballast tank

Drive System	:	Habasit Belt, Turbine-Pulley (200 mm) Generator-Pulley (100 mm)
Penstock Type & Length	:	M.S 310 mm ID, 3.5 mm, 239 m length
Length of T & D Lines (m)	:	H. T. Line (11000 V) is 6655 meter by L.T. (400 V/230 V) is 22760 meters (Three phase-11328m and Single Phase-11432m)
Pole Type & No	:	Wooden, 271-8.0 m ht, 285-7.0 m ht, Tubular-136-9.0 m ht
Ownership	:	Community
Productive End uses	:	Agro-Processing, Rural Carpentry, Bakery, Computer Lab, High Vision Hall, Dairy Factory and Cable TV Network
Proposed Tariff	:	Rs. 2.95 /Watt/month for HH lighting Rs. 11.0/kWh for end uses
Average Subscribed Power	:	100 Watt per HH

Project Costs

Total Project Cost (Rs.)	:	13,773,857.00
Cost per kW (Rs.)	:	344,346.00
Total Non Local Cost (Rs.)	:	12,547,759.00
Total Local Cost (Rs.)	:	1,226,098.00

Source of Finance (Rs.)

Subsidy	:	6,200,000.00
Bank Loan	:	2,383,374.00
Community Equity (Local costs)	:	1,226,098.00
Community Cash Contribution	:	2,587,000.00(Rs. 6500 per HH)
(DDC+VDC) Investment	:	1,377,386.00

Financial Analysis

Interest Payment	:	10%
IRR	:	10.94 %
NPV (Rs.)	:	423978, at 10 % rate (Discount Rate of 6%, 15 yrs)
B/C Ratio	:	1.35
Payback Period	:	7.0 yrs.

TABLE OF CONTENT

EXECUTIVE SUMMERY

Odare Marbu Micro-hydro Project is located on the right bank of Odare Khola in Bhakanje-VDC of Solukhumbu District.

The Odare Marbu MHP is found to be feasible technically, economically and socially as well. The site for the scheme is in stable region and hence the components of the scheme do not need any major protection measures**.** The geology of the site is sound which has made the project feasible geologically too. The project is feasible technically in the sense that its fundamental components have been designed without consideration of severe consideration of natural forces as high debris movement, intermittent land slide, flood, fault zone, cracking possibilities and many more anticipated natural forces that may turn the project unfeasible if they are likely to occur in the topography of proposed scheme.

Odare Marbu Micro- Hydro Project is a runoff river type with the source as Odare Khola. Analysis shows that the source is perennial and has sufficient discharge even in dry season. The plant is designed with installed capacity of 40 kW in according to the present demand. The scheme will provide electricity to the residents of ward no - 1, 2, 3, 5, 6, 7 and 8 of Bhakanje VDC of Solukhubu. The electricity generated will be utilized mostly for household uses along with some end uses. Altogether 398 households from the settlement will be benefited from the scheme. The gross head and design discharge of the scheme is 51.47 m and 139 Lps respectively resulting the total power generation of 40 kW with overall efficiency of 57 %.

The survey team measured the discharge of 216 lps on 13th May 2008. The date of discharge measurement doesn't imply to the date specified by the MGSP standard but the discharge during measurement was quite low. The lowest flow in the Odare Khola based on hydrological calculations for ungauged MHP River is 118.59lps. Taking consideration of 5% and 10 % of measured discharge for water losses due to evaporation /flushing/ seepage and downstream water release due to environmental reasons respectively, 139 lps with 11 month exceedance probability is taken as the design discharge for the proposed MHP. The detailed survey data shows that there will be end use diversification with the implementation of the project in years to come. Among the different end use possibilities, agro processing mill, Rural Carpentry, Bakery, Computer Lab, High Vision Hall, Dairy Factory and Cable TV Network will also be potentially installed after the project implementation.

The total cost of the project is Rs. 13,773,857.00. And the cost per kW is Rs. 344,346.00. The project would receive Rs 6,200,000.00 as subsidy to the MHP through the AEPC/ESAP. An amount of Rs. 2,383,374.00 would be mobilized from Bank. Besides, the community people would mobilize Rs. 1,226,098.00 through voluntary labor and local material contribution. The villager will also contribute Rs. 2,587,000.00 from the cash contribution of Rs. 6500 per household. 10% of the total project cost (Rs. 1,377,386.00) would be mobilized by DDC and VDC.

ACKNOWLEDGEMENT

The Detailed-feasibility study of Odare Marbu MHP was brought to effect after awarding the assignment to GREAT Nepal JV Development Network P. Ltd. For the purpose of fulfilling the above task, a well managed survey team with sufficient equipment was mobilized.

We would like to express our sincere acknowledgement to Alternative Energy Promotion Center / Energy Sector Assistance Programme (AEPC/ESAP) for providing this opportunity to conduct the feasibility survey. Required drawing and design is prepared according to the information and guidelines provided by AEPC/ESAP. And the cost estimate report is prepared considering present market rate of materials and local material rate.

And at last but not the least, we would like to express our acknowledgement to the local villagers for their support and for delivering valuable information, co-operation during the site visit and as well as for their hospitality during that period

We hope that the study will truthfully reflect the villagers lighting problem and their desire to implement the proposed MHP.

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Technical Director
GREAT NEPAL Pvt. Ltd
Kathmandu

ACRONYMS AND ABBREVIATIONS

ACSR	-	Aluminum Conductor Steel Reinforced
AEPC	-	Alternate Energy Promotion Centre
Amp	-	Ampere
BOQ	-	Bill of Quantity
CM	-	Community Mobilizer
Cu.m	-	Cubic Meter
DDC	-	District Development Committee
EIA	-	Environment Impact Assessment
E/M	-	Electromechanical
ESAP	-	Energy Sector Assistance Programme
kg	-	Kilogram
km	-	Kilometer
kV	-	Kilo volt
kVA	-	Kilo Volt Ampere
kW	-	Kilo Watt
kWh	-	Kilo Watt Hour
LA	-	Lightning Arrestor
LPS	-	Liter per second
LT	-	Low Tension
MCB	-	Miniature Circuit Breaker
m	-	Meter
MHP	-	Micro Hydro Project
MIP	-	Medium Irrigation Project
PCC	-	Plain Cement Concrete
PCD	-	Pitch Circle Diameter
PDP	-	Power Development Project
RCC	-	Reinforced Cement Concrete
REDP	-	Rural Energy Development Programme
RPM	-	Revolution per Minute
Rs.	-	Rupees
Sq. m.	-	Square Meter
UNDP	-	United Nations Development Programme
VCDP	-	Vulnerable Community Development Plan
VDC	-	Village Development Committee

Chapter 1
INTRODUCTION

1.1 Back ground

Nepal is a mountainous country. Hence most of the areas are very remote and are far from the approach of the modern technology. The rural sector is occupying an important place in the national economy of the country in the sense that high percentage of population, more than 80 % live in the rural areas. The overall performance of the country in the area of socio-economic development is largely influenced by the development of the rural areas. The level of development of the rural areas as compared that of the urban areas lagged far behind even to this day. The rural sector is largely traditional and under developed in the country.

The Odare Marbu Micro Hydro Project was reported as feasible for detail study, after preliminarily surveyed done by field verification adopting carpet approach. For detail feasibility study of the Odare Marbu MHP, a contract was signed between GREAT Nepal JV Development Network P. Ltd. and developer of Odare Marbu MHP. In accordance to that contract, this report is the final outcome of the technical and socio economic aspects of the field survey and interaction during meeting with Odare Marbu MHP beneficiary.

The site was visited by a Engineer and helper of the consultant. The site was visited from 12^{th} May to 17^{th} May 2009. Professionals as enlisted below visited the site:

Table 1: Name of Manpower

Name	Designation
Dambar Karki	Engineer
Prakash Magar.	Helper

1.2 Objective of the Study

Power is the basic tool for development activities in any village. With the realization of this fact this study has been carried out. Basically, the followings are the objectives of the study. From analyzing various projects, the study shows that most of the project fails due to the improper analysis of the hydrology, failure in civil structure and also in selection of the appropriate and sufficient electro-mechanical components. Considering all the issues following objectives have been noted to carry out the feasibility study of the project.

- Hydrological study and flow measurement
- Carry out survey for appropriate structures, their location and design
- Design appropriate and suitable electro-mechanical equipment
- Design transmission / distribution lines
- Identification of potential load and load center / demand of power
- Identification of environment and issues related to water right

- Identify any other suitable measures for the futures sustainability
- Discuss about the technical and socio- economic aspects of the proposed scheme

1.3 Methodology

The entire work of the Detailed Feasibility Study was carried out in two stage viz fieldwork and desk (office) work.

1.3.1 Field Work

The survey team comprised of a Civil Engineer and survey helper were employed for carrying out technical survey. The survey was performed with the active participation of the developer and the villagers.

To start with, the team made a comprehensive reconnaissance survey around the village and along the existing canal and stream bank with the villagers. Consultations were made with local teachers, social workers and senior citizens of the locality, who were present in the village during the time. With the thorough analysis of the situation, detailed measurements were carried out to locate the best suitable intake, proper canal alignment, stable forebay location and powerhouse.

The team carried out detailed engineering survey of intake area, alignment of the headrace conveyance, forebay and powerhouse locations and exit of the water (tailrace and spillway). The transmission / distribution line was also measured with due considerations of having least adverse impact on environment and aesthetics. The team tried to make the T/D lines shortest possible and the alignment in the stable place. Due attention was given to have multipurpose use of water, both for irrigation and power generation.

The detail survey was done with the help of an Abney Level, 50m and 5 m tapes. The detail survey was done within the principles of leveling. The flow measurement was done by the salt dilution method using conductivity meter.

1.3.2 Office Work

After the completion of the fieldwork, the team proceeded to analyze the data and work out designs of various components. All the data and information were carefully analyzed to come to the final and detailed designs of all the necessary components. The views and suggestions were duly taken into consideration while carrying out the detail designs of the scheme. The design of all civil as well as electro-mechanical components was carried out following AEPC/ESAP guide lines & design spread sheets. And necessary drawings were prepared. This detailed feasibility study report is the outcome of the survey conducted.

Chapter 2
GENERAL PROJECT DESCRIPTION

2.1 Locations and Accessibility

The proposed micro-hydro project is in Bhakanje VDC of Solukhumbu District. Solukhumbu District lies in the Sagarmatha zone, Eastern Development Region of Nepal. It is one of the mountainous regions with full of slope terrain. The proposed site is situated at about 2129 m (power house elevation).

It takes about 2 days walk for normal and about 4 days for loaded porter to reach the site from the nearest roadhead Jiri (Aaraniko Rajmarga) and 2 days walk from the nearest airfield at Palpu, Solukhumbu district.

2.2 Topography and Geography

The topography and geography condition of the proposed site is found to be fairly stable enough. The average altitude of the proposed site is situated in 2129 AMSL. Most of the proposed project area lies in moderate sloppy area with full of slope terrain. No any sign of major landslide and other instability were found during the site visit. The headrace alignment is along the cultivated clayey land and hard rocky slopes.
All the components of the proposed micro hydro project, lies on the right bank of the Odare Khola.

The proposed intake and diversion location is at the right bank of Odare Khola, and lies in stable place and possibility of bed scouring is also less. The bank of the Khola is also strong and stable enough. The alignment of the headrace runs through right bank of the Khola, which consists of uncultivated rocky and cultivated clayey terrain.

2.3 Climates and Vegetation.

The proposed project site is located in Solukhumbu District, Eastern Development region of Nepal. The District lies in the MIP region 3. The two seasons of the year are well marked with typical variations. Due to the high altitude, the climate is suitable for growing different types of plant and vegetation. The natural vegetation in this project area changes with the variation in elevation, soil regime and slope. Agriculture is the most predominant land use pattern of the area both geographically and economically. Major land use category of the VDC includes agriculture land, forest and bushes, hard rock and mountain, rivers and stream banks. The natural vegetation around the project area consists of bushes, Lokta, soft wood trees and hard wood trees. Major agricultural products are Oilseed, Wheat, Rice, Maize, etc

2.4 Project Area and Facilities

The target area covers Bhakanje VDC. The number of household in beneficiary area is 398. There are Primary Schools in the area.

2.5 Hydrology and Water Right Issues

The source of flow is Odare Khola, which is a perennial stream. The flow in the stream was measured following salt dilution method using conductivity meter. The flow was measured on 13th of May 2009, which doesn't follow the MGSP guideline of measurement of discharge but the water during the measurement was quite low and sounded feasible.

The hydrological calculation is based on MIP method. The site lies on the MIP region 3. The design discharge was calculated considering about 85% of 11-month exceedance, 5% for water losses and 10% for downstream release. It is found to be 139 lps which is quite safe. The average monthly flow using the MIP method is presented in the table below.

Table 2: Mean Monthly Flow, Odare Khola

Date of Flow Measurement: 13th May 2009, Flow Measured: 216 lps

Month	Flow at River, lps
January	321.39
February	222.96
March	163.66
April	**118.59**
May	222.96
June	371.20
July	1605.77
August	2964.86
September	2470.32
October	1235.75
November	592.97
December	444.73
Annual Average	**894.597**

So far as the water right issues concerned, there is not as such any serious conflict on water use. The water needed for the plant can be diverted without any conflicts. The matter of water use was thoroughly discussed amongst the community people.

2.6 Energy Consumption Pattern

2.6.1 Present Situation

All most all the people in the village used wood as their sources of energy for cooking and kerosene for lighting. Firewood is being used extensively as the major source of energy and it is being largely consumed for residential purposes. Consequently, massive encroachment of forests has taken place due to fuel wood collection. Kerosene is mainly used for lighting.

2.6.2 Domestic Demand of Electricity

The study shows that almost the entire village has minimum 2 to maximum 4 rooms. That means an average demand of electricity is between 2 to 4 bulbs, which will be enough. Considering the average demand and the production of electricity about 100 watt per household is proposed for the electricity, which is just sufficient to illuminate four incandescent bulbs of 25 watt. Furthermore, the technological advancement in the area of efficient lighting (CFLs) would solve the future demand of peak hour lighting. The community people discussed in length about the matter during the detail survey of the MHP and came to the conclusion to include all the households of the locality (398 households). Study shows that the peak demand of electricity has been coming from household lighting in morning and in the evening. In addition to household lighting, for the use of daytime energy there is possibility to promote different kinds of end-uses by providing technical training and other kinds of supports.

2.6.3 Potential End Uses

Electrical energy is one of the least cost options for income generating activities in the remote rural area. The proposed MHP is designed to produce 40 kW, which can only meet the peak demand for lighting, so the end-use application will be done mostly during daytime. As per survey of the area and views of the local people, the following end uses of electricity seem possible with optimum and managed use of available electric power.

Agro-Processing

Based on the survey on agriculture production and the assessment of quantities that could be processed in the beneficiary area it has been found that there is the potentiality for the establishment of an agro-processing mill. At present most of the local people are using the traditional way of agro-processing which is time consuming and also needs more strength. As per the survey and discussion with the local people, people seem interested to operate the agro-processing mill themselves. Based on the survey, there seems a good potentiality for an agro-processing mill. An agro-processing mills of consuming kW running for 5 hours per daytime (7 am to 12 pm) and 250 days per year is established in the surveyed as well as other near villages also.

Rural Carpentry
The area has very good vegetation of forest with different types of trees. So it is very much possible to run a saw mill for wood works to promote rural carpentry. There are skilled carpenters in the project area, who make furniture by using manual tools to meet local demand. With the establishment of the industry, the quality of the products would be enhanced, thus would also increase their demand. As per discussion with the community people, such workshops would be established in the community, which would consume 4 kW for 5 hours a day during daytime (12 pm to 5 pm) and 275 days per year. This industry would be registered in the District Cottage and Small Industry Office and/or District Forest office at the District Level.

Bakery
According to local people bakery will be a best endues for this micro hydro plant because the project covered the local bazaar of VDC. Also the community wants to have a bakery with them. It is estimated that the bakery will consume 5 kW running for 4 hours per day during nighttime (11 pm to 3 am) and 275 days per year.

Computer Lab
The Micro Hydro Project also cover the two number of school so computer lab will be a best endues in the day time. According to local person and local teacher they want a computer lab in their school which consumes 6 kW for 6 hours a day during day time (11 am to 5 pm) and 250 days per year.

Dairy Factory
The micro hydro project is situated at rural area of Solukhumbu district. Most of the people have domestic animals. So the dairy factory is one of the main endues of the project and they wants with them. Thus, a Dairy Factory of 5 kW running for 3 hours per a day during Morning time (7 am to 10 am) and 275 days per year.

High Vision Hall
According to the young people high vision hall will be a good endues for this project. At the time of festival and occasion the people is gathering and it may be internment. So the High Vision Hall is one of the main endues of the project and they wants with them. Thus, a High Vision Hall of 3 kW running for 3hours per a day during Morning time (7 am to 10 am) and 120 days per year.

Cable TV Netwoek
According to local people cable TV net work will be a good endues which consume 4 kW running for 5 hours per a day during day time(12 pm to 5 pm) and 275 days per year

Table 4: Possible End Uses

End Uses	kW Demanded	Tariff Rate (Rs./kWh)	Operation		Annual Energy Consumption (kWh)	Income (Rs.)	Remarks
			Hrs./ Day	Days/ Years			
Agro-processing mill	6	11.00	5	200	6000	66000.00	
Bakery	5	11.00	4	275	5500	60500.00	
Rural Carpentry	4	11.00	5	275	5500	60500.00	
Computer Lab	6	11.00	6	250	9000	99000.00	
High Vision Hall	3	11.00	3	120	1080	11880.00	
Dairy Factory	5	11.00	3	275	4125	45375.00	
Cable TV Network	4	11.00	5	200	5500	60500.00	
Total					**36705**	**403755**	

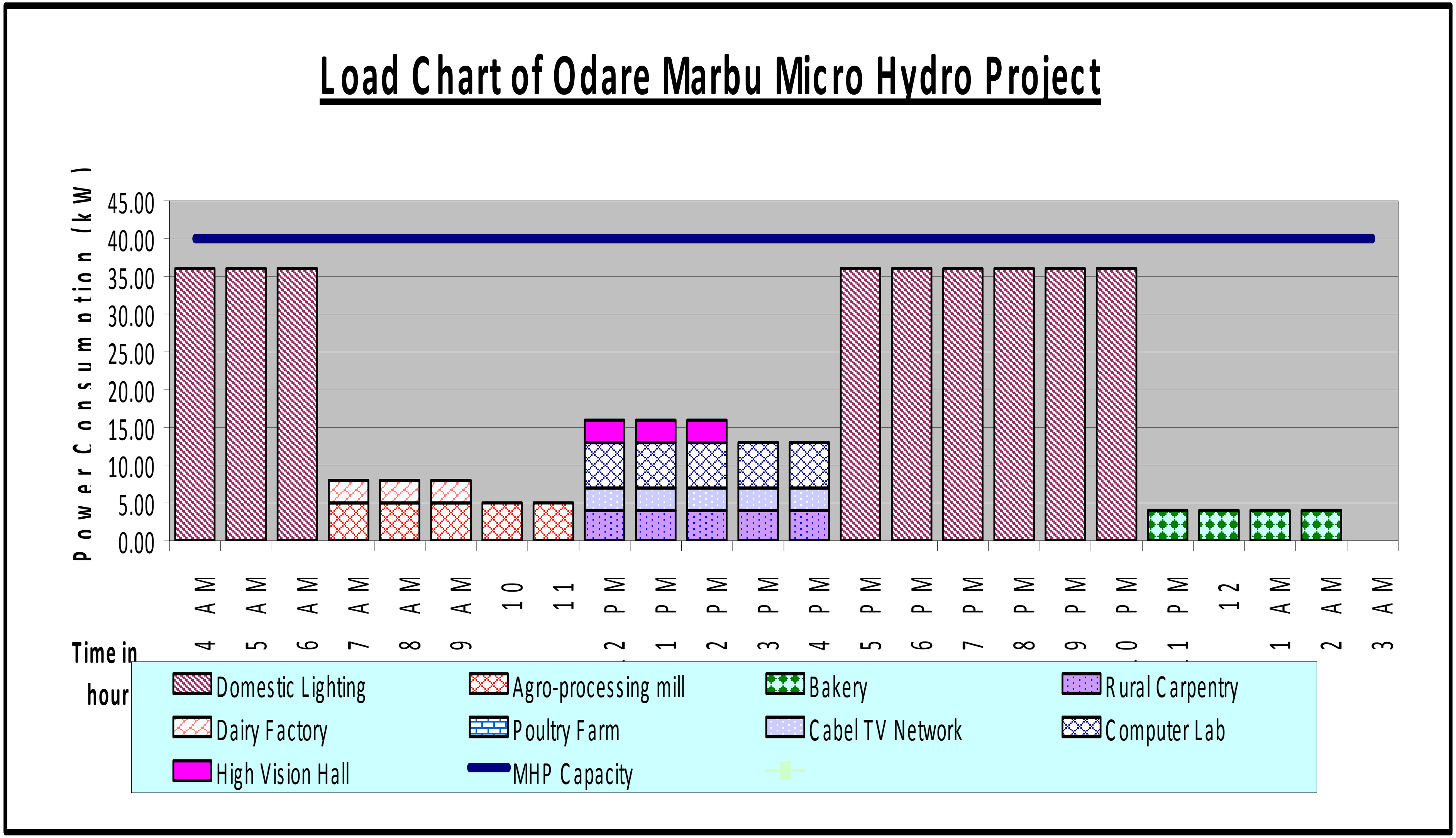
2.6.4 Expected Load Demand Pattern

The expected load demand pattern (Watt) over 24 hours period has been provided in the following table.

Table 5: Expected Load Demand Pattern

End Uses	4AM ~ 7AM	7AM ~ 10 AM	10 AM ~ 11 AM	11 AM ~ 12 PM	12 PM ~ 3 PM	12 PM ~ 3 M	3 PM ~ 5PM	5PM ~ 11PM	11 PM ~ 4 AM
Domestic Lighting	**40 kW**							**40 kW**	
Agro-processing mill		**6 kW**	**6 kW**						
Bakery									**5 kW**
Rural Carpentry					**4 kW**	**4 kW**	**4 kW**		
Computer Lab				**6 kW**	**6 kW**	**6 kW**	**6 kW**		
High Vision Hall					**3 kW**				
Dairy Factory		**3 kW**							
Cable TV Network					**3 kW**	**3 kW**	**3 kW**		
Total Power (kW)	**40**	**9**	**6**	**6**	**16**	**13**	**13**	**40**	**5**

***The agro-processing units and other end use should be run at different times during the day without overloading the plant.**


Load Chart of Odare Marbu Micro Hydro Project
Power Consumption (kW)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Time in hour
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10
11
2 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
0 PM
1 PM
12
1 AM
2 AM
3 AM
Domestic Lighting
Agro-processing mill
Bakery
Rural Carpentry
Dairy Factory
Poultry Farm
Cabel TV Network
Computer Lab
High Vision Hall
MHP Capacity

2.7 Socio-economic Condition and Affordability

The proposed project area is situated in Eastern Development Region. There are 398 houses benefited from the project. The dominant ethnic of the proposed project area is Gurung and Dalit.

Agriculture and cattle rising is the main source of income of the people. In recent days most of the young generation are interested in foreign employment and several has been also gone aboard. The project area is economically active area of the district and most of the people have well understanding and commitments on work.

The average landholding per household in the village is about 12 ropanis. Rice, wheat, Oilseed and maize are the main crops. People also keep livestock to improve their economy. Poultry farming, Cow, Goat, Sheep, etc. are species kept by the villagers. The economic status of the villagers is good. About 90 % of the population is capable to pay the electricity bill and have good understanding about the electricity.

The educational background of the project area is also fair. There are 200 members literate, more than 40 people with education of SLC or more, and more than 7 people with education of +2 or more and more than 8 people with education of university or more.
The status and interest of the women in the area is medium and possess high levels of enthusiasm for the development of project, which is expected to change the current status of the village and the villagers with the implementation of the MHP.

Due to the implementation of the micro hydro project, high quality of lighting system would improve living condition along with the health and environment. It will also provide more time for students to study and will improve the education system in result. The efficient end uses will reduce time and cost, and will also generate new sources of income, which ultimately will improve economic condition of the local people.

2.8 Plant Size and Power Requirements

Before effective design of hydropower project, one must consider the coordinated use of the stream water for power generation as well as other local purposes. The site for the powerhouse is selected in such a way that the water from the tailrace can safely be discharge to the parent stream. No serious water right issues have been observed during the survey. The hydrology and water right issues were already discussed in 2.5.

Power (P) = η x Q x H_g x g
= 40 kW

Where,
Q = Discharge in lps- 139 lps
H = Gross Head in m- 51.47 m
η= Overall Efficiency of System (57%)
g = Acceleration due to gravity, 9.81 m/sec2

Where,

Penstock	= 95%
Efficiency of turbine	= 70%
Efficiency of Drive system	= 97%
Efficiency of Generator	= 89%

All the project structures are proposed to be constructed on the right bank of Odare Khola. The tail water will be safely discharged to river. The length of the tailrace canal is 15 m.

Chapter 3
TECHNICAL ASPECTS OF THE MHP

3.1 Civil Components

3.1.1 Intake Structure and Diversion

The intake structure is proposed at right bank of Odare Khola. In consideration of the flow of the river, semi temporary type diversion structure of gabion fill with stone of approximate height of 2m and 12 meter long is proposed to be built across the Khola. The gabion of 6 m is also proposed at the right side of khola which protect the canal from flood The proposed weir is of low cost and utilizes locally available materials which could be easily maintained after damaging by the flood during rainy seasons. The respective position of weirs and other fundamental components of MHP are shown in drawing entitled 'General Layout'.

An intake canal with coarse trash rack is proposed to avoid the coarse sediments entering the canal. The intake canal runs from intake to Settling Basin at 60 m chainage from the intake. The intake canal is proposed of stone masonry in 1:4 cement mortars with 1:4 cement plasters. A sluice gate is provided at the entrance to intake canal before the coarse trash rack. Details of the head works are given in the drawing.

3.1.2 Headrace Conveyance

The headrace canal runs from intake to. The overall length of the canal is 271m excluding settling basin. We have taken 5% water loss in canal while designing. The stone masonry canal is proposed of cement mortar of 1:4 with inner surface plaster with 1:4 c/s. The stone masonry canal is proposed to be of 30 cm wall thickness with 45 cm depth including 15 cm freeboard and 50 cm width. The details of the headrace profile and section are shown in drawing.

3.1.3 Settling Basin

Settling Basin is proposed at 50 m from intake. The basin is fed by the canal and discharges to headrace canal. The basin is designed for settling particles. The settling basin is designed considering 2 kg/cm3 sediment concentration in order to settle particles larger than 0.3 mm. The internal size of the basin is proposed of 6.0 m x 1.5 m (inside of settling area only). The basin is designed to flush at every 12 hours and manually. A flushing gate is of 1.20 m height and 0.50m x 0.50m opening is proposed for flushing settled sediments. . A spillway of 5.0 m is provided to spill excess flow if entered the settling basin.

3.1.4 Forebay

The Forebay is proposed at the end of headrace canal. It is designed for settling particles that escaped the settling basin and to discharge water to penstock. The forebay is designed considering 1 kg/cm3 sediment concentration in order to settle particles larger than 0.2 mm. The internal size of the basin is proposed of 6.0 m x 1.5 m (same as settling basin). The forebay is designed to flush at every 12 hours and manually. A flushing gate of 1.20 m height and 0.50m x 0.50m opening is proposed to flush the settled particles. A spillway of 40 m is provided to spill excess flow if entered the forebay which meets the tailrace canal which meets the Odare khola. A canal as the same dimension of headrace canal is proposed for safely discharging flushed sediments as well as over flow to the river. A fine trash rack (0.80m x 1.50m) is provided in order to prevent any debris entering the turbine via penstock. And also air vent pipe of 50 mm dia GI pipe is proposed on the forebay.

3.1.4 Penstock, Anchor Block & Support Piers

According to the available head, a mild steel pipe of 310 mm ID is proposed. The overall length of the penstock is 239 meter and 3.5 mm thickness.

The M.S pipes are proposed of about 2.5 meters in length, rolled/ welded having flange at each end connected together. Flange should have 14 mm thickness and properly welded together with the pipe. The details of penstock profile are given in the drawing.

The anchor blocks and the support piers are designed to support the penstock pipe. Anchor blocks are proposed to be designed at every vertical bend and at 30 meter spacing at the straight section. Altogether 10 numbers of anchor blocks are required along the penstock pipe. After each anchor block expansion joints are placed. Each anchor block is constructed of 1:3:6 PCC with 40% plum concrete. Altogether 54 nos. of support piers are designed. Spacing of support piers varies and shown in drawing. Support piers are constructed of stone masonry in 1:6 c/s mortars. These blocks are designed considering the stability, bearing capacity of soil, thrust pressure and water pressure. The details of the blocks are given in the drawing.

3.1.5 Powerhouse, Machine Foundation & Tailrace

The powerhouse is proposed to be located on the thick bushes land. It is located in flatter portion of land having sufficient space for building the house. The powerhouse is sufficiently above the flood level. The powerhouse consists of internal dimensions of 5.0 m lengths, 4m widths and 2.5m heights for machine room. Similarly operator room of internal dimension 3.0 m lengths, 2.5 m widths and 2.5 m heights. The building is to be built of locally available stone masonry walls with mud mortar. The roof is to be covered with CGI sheets and CGI sheet riding with wooden rafters and purlins.

Machine foundation has been designed as required to be in safer side against overturning, bearing pressure and sliding considering the forces due to maximum expected surge head, weight of turbine and weight of generator. A minimum of 20 mm diameter, 700 mm long anchor bars are to be used to fix base frame to the machine foundation. 10 mm diameter

tor steel bars are to be used for reinforcement. Maximum spacing to be provided is 150 mm in turbine pit and 300 mm on other faces. Lap length will be 400mm on other faces. Lap length
shall be 400 mm min. Minimum reinforcement cover shall be 50 mm. Structural concrete shall be 1:2:4 mix. 10 mm width of sand and gravel has been placed at periphery of machine foundation down to depth of powerhouse floor. The details of the machine foundation are given in the drawing.
A stone masonry tailrace canal is proposed from the powerhouse after the turbine to discharge the water back into the stream. The length of the tailrace canal is about 15 m. It will be of about 50 cm width and 50 cm depth in dimensions which bigger than headrace canal.

3.2 Electro-mechanical Works:

Most of the electromechanical components would be manufactured / fabricated in Nepal. The topic gives a brief description about design and selection of the components proposed for the project.

3.2.1 Trash rack

A coarse trash rack is proposed at the intake. The proposed size of the coarse trash rack is 60 cm x 70cm. The trash rack is proposed of 5 x 40 mm steel plate with 50 mm c/c spacing of the bars and inclined at 1:3.

A fine trash rack is proposed at the forebay. The proposed size of the fine trash rack is 80 cm x 150 cm. The size of angle iron of the proposed trash rack is 30x30x5 mm as well as the size of flat iron is 30x5mm @ 35 mm c/c spacing of the bar

The details of the trash racks are given in respective drawings.

3.2.2 Penstock layout, Expansion Joints & Pressure Gauge

According to the available head, a mild steel pipe of 310 mm ID is proposed. The overall length of the penstock is 239 meter and 3.5 mm thickness.

The M.S pipes are proposed of about 2.5 meters in length, rolled/ welded having flange at each end connected together. Flange should have 14 mm thickness and properly welded together with the pipe. The details of penstock profile are given in the drawing.

Expansion joints are also designed for the movement of the pipes during the temperature variation. The thickness and size of the joints are decided on the basis of the temperature variation of the scheme. The maximum temperature of the site is considered 40 degree and minimum as 4 degree. Altogether 10 nos of expansions joints are enough. An air vent pipe of 50 mm diameter is proposed at the starting point of the penstock pipe.

Pressure gauge measures the pressure head at the end section of the penstock. The size of the pressure gauge depends upon the gross head of the scheme. For the gross head of 51.47 m we need the pressure gauge of size 5 BAR and considering factor of safety pressure gauge of 10 BAR is proposed.

3.2.3 Turbine

The scheme has gross head 51.47 m and design flow is 139 lps. So the generated power is 40 kW. For this purpose, Cross flow turbine is recommended. Though, each manufacturer has their own design and product specification we have recommended the following major specifications of the turbine. (Detail design will be as per the manufacturer at the time of manufacturing with required output.)

Specification of the proposed turbine is as follows:

Type	: Crossflow
Valve	: Butterfly (Gear Operated)
Runner rpm	: 960
Runner Diameter	: 300 mm
Runner width	: 100 mm
Discharge	: 139 Lps.
Turbine Shaft Power	: 54 kW
Efficiency	: 70%

3.2.4 Generator

A three phase self-excited and regulated, brush-less synchronous generator that is rated to continuously deliver 40 kW at 0.8 power factor at the given site condition is proposed. The generator size and type should be compatible with the electronic regulation system i.e. ELC. The construction and bearings of the generator should be rated to withstand runway speed under fault condition. The bearings should further take the static load exerted on them by the drive system. The brush less synchronous generator of 83 KVA is proposed for the scheme. The proposed generator has following specification:

Type	: 3 Phase brushless, self excited, self regulated, Synchronous Generator
Frame size	: NRF 250/4
Capacity	: 83 KVA
Speed	: 1500 rpm
Frequency	: 50 Hz
Power factor	: 0.8
Efficiency	: 89%
Nos. of pole	: 4
Rated Voltage	: 400/230 V
Connection	: Star
Insulation Class	: B
Environment Protection	: IP21
Standards	: BS-4999/1977

Excitation System: The generator field obtains the excitation from the overhung exciter and rotating bridge rectifier. The exciter field is controlled by Automatic Voltage Regulator (AVR) which is mostly internally mounted on the generator. Its voltage regulation is +/- 2.5%

3.2.5 Drive System

The drive system transfers the mechanical energy from the Turbine shaft to the generator rotor at required speed. Here, the speed of the turbine is 960 rpm and the generator rated speed is 1500 rpm. So, the gear ratio should be 1:2. For this, Flat Havasit Belt with pulley is recommended. The belt could get loose after some period of operation. A sliding mechanism should be incorporated in the generator base to tight the belt. Also the belt guard is to be provided for the safety of the operator.

<u>Specification of the drive system</u>

Type	: Flat Havasit Belt
Gear ratio	: 1:2
Pulley on Generator Shaft	: 200 mm diameter.
Pulley on Turbine Shaft	: 100 mm diameter.

3.2.6 Control System

<u>Electronic Load Controller (ELC):</u>
The Electronic load controller is recommended to maintain the speed and frequency of electricity generated. An ELC with ballast unit is proposed to control the system load such that the generator is always operating at full load. In other words, it is necessary to keep the supply in balance with the demand in order to avoid the overloading and under loading of the generators. The specifications of the proposed ELC are as follows.

Type	: Locally assembled
Capacity/Phase/Voltage	: 40 kW/3ph/415V
Frequency	: 50Hz
Frequency Regulation	: +/- 0.5-1%
Accessories	: Thyristor, ELC Board along with OV/UV, OF/UF Protection system and ELC extension.

The box enclosing ELC (Panel Board) should contain meter showing current, voltage and frequency output of the generator, kW meter and one energy meter (kWh meter).

<u>Ballast load:</u>
It is used as a dummy load to work along with ELC to maintain constant load to the generator. Water immersion heater with tank of 48 kW/ 220V/ 3ph is proposed to be installed as dummy load at separate water tank with continuous inlet and outlet flow of water. Though, we have recommended the above major specifications of the ballast load, each manufacturer has its own design and product specification (Detail design will be as per the manufacturer at the time of manufacturing with required output).

3.2.7 Powerhouse Cabling

120 mm^2, 4-core armored copper power cables are proposed to connect generator, panel and dummy load inside the powerhouse and 180 mm^2, 4 core aluminum armored power cables are proposed for the connection between the main switch and the first pole. Cable ratings are proposed such that they can carry at least 150 percent of the required maximum current. At least 3 light points with incandescent lamps and one power point with necessary switches and fuses are proposed for the powerhouse use. The details of power single line diagram are given in the drawing in Annex

3.2.8 Transmission / Distribution Network

The generated power is proposed to be transmitted and distributed to the load centers via 3 phases, 11 kV High-Tension (H. T.), 0.4 kV Low-Tension (L. T.) overhead lines and single phase 230V overhead lines. The design and construction has been simplified with an overview to reducing the project cost by using locally available resources as much as possible.

The total length to be covered by H. T. Line (11000V) is 6655 m and that by L.T. (400 V/230 V) is 22760 meters (Three phase-11328m and Single Phase-11432m). The transmission and distribution network consists of poles, transformers, conductors and insulators.

Since the transmission line is long, so a 40 kVA step-up transformer is proposed at power house and two step-down transformers one of size 25 kVA and one of size 15 kVA at the locations shown in the diagram in annex.

The transmission and distribution network consists of poles, transformers, conductors and insulators.

Poles

9 meter Tubular Swage Poles has been proposed for the H. T. line and 8 meter wooden poles are proposed for the L. T. line and 7 m wooden poles for single phase lines. Altogether, 136 tubular poles and 556 wooden poles have been proposed (271 wooden poles of 8m for L.T. three phase lines and 285 wooden poles of 7m for single phase lines). At least 1.5 m in case of tubular and 8 m wooden poles, and 1.2 m in case of 7 m wooden pole should be inserted into the ground. The lower portion of the pole should be coated with bitumen paint in such a way that at least 0.3 m painted length would be above the ground level. The average pole-to-pole distance in case of tubular pole is considered as 50m. The recommended pole-to-pole distance for wooden pole should be spanned by 35 meters. It is recommended not to exceed the wooden pole span more than 40 meters. For the 11kV transmission line, cross arms of 1.1m are recommended for supporting insulators.

The specification of the poles is as follows:

Specifications	Wooden poles for 3 phase L.T.	Wooden Poles for single phase lines	Tubular poles for H.T.
No. of Poles	271	285	136
Spacing	35 m	35 m	50 m
Pole Height	8m	7 m	9m
Min. ground clearance	5 m	4.0-4.2 m	5.5 m
Conductor spacing	30 cm (vertical)	30 cm (vertical)	*See note below
Min. top diameter	140 mm	125 mm	5 inch

* NOTE: For H.T. lines, the 11kV conductors are placed in triangular shape while L.T. lines are placed vertically. The details of diagram are given in the drawing.
For H.T. lines only, the conductor spacing is 62.5 cm horizontally. For L.T. lines, the conductor spacing is 30 cm vertically.

Transformer

As the load centers are far away from the powerhouse, there is considerable loss in the system. So transformers are proposed to overcome the situation. There are needs of 3 nos. of transformers. One step up transformer at the power house and two step down transformers within load center points (location of transformer is shown in fig).The transformers rating are shown below in the tabular form. The name given for the transformers are as per drawing. The location of the transformers is given in the drawings in annex.

Transformer	Rating
Tph (At powerhouse) (step up) star/delta	40 kVA (400V/11kV)
TR1 (step down) delta/ star	25 kVA (11kV/400V)
TR2 (step down) delta/ star	15 kVA (11kV/400V)

The proposed transformers have the following specifications:

Class : O (Oil immersion)
Phase : 3
Frequency : 50 Hz
Insulation Class : A
Voltage Rating : 11/0.4 kV
Impedance : 4%
Quality Certification : ISO 9002, IEC76

The transformers are to be provided with the transformer mounting frames. The transformer mounting frames and accessories are shown in drawing in Annex.

Stay set

Stay sets are required at every bends, first pole and last pole of the transmission and distribution and in steep slope upward. Generally, for safety, every 5th pole is to be stayed on both sides even if the poles are in straight line, so as to provide protection from storms according to the standard. The stay set consists of MS rod, stay bow, stay insulator, turn buckle and anchor plate. There is need of 139 numbers of stay sets. However, the number of stay sets may vary depending upon the site condition.

Conductor

For the transmission/distribution of the generated power, the following Aluminum conductor Steel Reinforced (ACSR) has been proposed.

Conductor	Length (km)
Squirrel	90.8776
Gopher	2.178
Weasel	3.8995

Total Households: 398 Households

Above lengths of ACSR conductors are incorporating 10% additional length due to sag. The conductor sizing has been done by keeping in mind anticipated peak load demand in each of the branch. The line material has been designed in such a way that maximum voltage drop at peak hours at the end of each distribution line will not exceed by 10 percent.
The details about the conductor used for transmission and distribution are shown in Annex.

Overhead Line Protection
The overhead ACSR transmission/distribution lines are to be protected from high voltage surge of atmospheric lightning by 0.5 kV lightning arrestors along L. T. Lines and 9 kV lightning arresters along H.T. lines. 69 nos. of lightning arrestors have been proposed for L. T. Lines (19 sets for 3 phase line and 12 nos for 1 phase line) and 7 sets (21 nos.) lightning arresters have been proposed for the H.T. lines. The positioning of the lightning arrester has been shown in details in the transmission line diagram in the Annex. The lightning arresters are proposed to be installed in 500 to 750 meters distance along the transmission/distribution line.
The specifications of the lightning arrester required are as follows:

Specifications	For L.T. lines	For H.T. lines
Rated Voltage	0.5kV	9 kV
Type and designation	MFTOVAR	-
Nominal rated current (peak)	10kA	10kA
Numbers	69	21

3.2.9 Earthings & Lightening Arrestors

All exposed metal parts of the generating equipments and generator neutral terminal are proposed to be earthed separately in a proper manner. Similarly, each lighting arrestors installed should be separately earthed. Apart from earth continuity from the powerhouse through the cable armoured up to the main distribution board, each distribution box is proposed to be properly connected to earth. It is proposed to do the earthing work with the same conductor and plate. Same earthing is used for high voltage and low voltage lightening arrestors (LA) if they are at the same location.

Three different earth pits at the Power House for
- One for neutral earthing.
- Equipment Earthing.
- Lighting Arrester Earthing.

The positioning of the Earthing system is shown in details in the transmission/Distribution diagram in the Annex

Specifications:
- For earthing at the power house and for the 3 phase H.T and L.T., 600mm*600mm*3mm copper plate.
Numbers: 34
Earthing wire: 8 SWG copper wires

GI pipe for the protection of Earth wire is also recommended. The copper earthing plate should be buried in a trench of minimum depth 2.5 m. Both the Step Up and Step Down transformers need to be grounded. For transformer grounding, Earth plate of 600mm*600mm*3mm copper plate should be used. The Step Up transformer that is near to the Power house can be connected to the equipment grounding of power house whereas the step down transformers at other positions should be grounded separately.

3.2.10 Protection System

The OV/UV and OF/UF Protection system senses the voltage and frequency of electrical output of the generator continuously. If the voltage or frequency exceeds prescribed level, the protection system output relay trips out. This trip can be used to set off an alarm or to completely shut down the power plant.
Specifications:

Input voltage range: 140-300 Vac
Output: Relay contact 250V/5A
Internal power supply: 12V+ regulated
Low- voltage trip level: 150-230Vac (adjustable)
High- voltage trip level: 230-290 Vac (adjustable)
Low frequency trip level: 35-50Hz (adjustable)
High frequency trip level: 50-65Hz (adjustable)
Trip indication: 4 LEDs

Moreover, the protection system should also include adequately sized MCCBs to protect against overload as well as short circuits without damaging the generator and other control equipment.
Specifications:
IEC: 898, IS:8828

	MCCB on the generator side	MCCB after ELC
No. of poles	3 pole with switched neutral	3 pole with switched neutral
Rated voltage	415V	415V
Rated Current at 415V	125 A	100 A
Breaking Capacity	30kA	30kA
Type	DV260	DV200

Moreover, Rewirable type Triple pole and neutral (TP &N) switch fuse of 160A is recommended to be used as main switch.

Apart from this, 3 poles with switched neutral MCCB are also provided on the primary side of Step up Transformer and on the secondary side of Step down Transformers as well, for protection of transformer.

MCCB Position	**Number**	**Current(A)**
MCCB on Step UP transformer TRph	1	100
MCCB on Step Down transformer TR1	1	63
MCCB on Step Down transformer TR2	1	32

3.2.11 Service Wire and Current Limiting Devices

At an average of 30 m per household, 12090 m long service wire is required. The service wire is of 6 mm^2 concentric cables. All consumer connections should be protected through MCBs of appropriate rating to suit consumer's peak wattage subscription. But wiring in each household is to be done by the owner.

Specification of household MCB is as follows:

Number of MCB	398
Rated Current	0.5 A
Rated Voltage	415/230 V
Breaking Capacity	5 kA

3.2.12 Insulators, D-iron Clamp and Drop out fuse (D/O fuse)

To lay the wire in poles Disc insulators, Pin insulators and shackle insulators are used. Shackle type insulators are used for the L.T. lines. While, Pin and Disc type insulators are used in 11kV transmission line.
The specifications of the insulators required are as follows.

Shackle Type:

S.N.	Size	Dimension	Used in Conductor	Numbers
1	Small	55mm*55mm	Squirrel	1846 Units
2	Medium	75mm*90mm	Gopher, Weasel	167 Units

Each set of Shackle type insulators is provided with D clamp, nuts and bolts.
Pin Type Insulators: 224 units.
Disc Type Insulators: 436 units.
The D.O. fuses are used for the protection of transformers.
The Drop Out fuses required for the transformers are 12. In numbers and D.O. operating rods are 1 in number; required for the operation of the D.O. fuse.

3.2.13 Cross arms

Cross arms are required for supporting the insulator (Pin and Disc) in the poles. Besides that, cross arms are also required for clamping DO fuses in the poles containing transformers and for making transformers mounting frames.
For poles supporting transformer (for double pole), cross arm of 2.2 m are recommended, while for other poles supporting insulators (for single pole), cross arm of 1.3 m is recommended.

- Cross arm of 2 m
  Numbers: 8 sets (Accessories: nut and bolts)
- Cross arm of 1.25 m
  Numbers: 128 sets (Accessories: nut and bolts)

Chapter 4
FINANCIAL ASPECTS OF THE MHP

4.1 Quantity Estimate and Rate Analysis

Rate analysis for the construction activities of the MHP has been done using Nepal Government norms. A district rate, published by DDC at Solukhumbu has been also considered while analyzing the rates. Since the project is in far remote place and will be constructed by the local people using available local materials, so the local available materials rates and local labor rates are also consider in the rate analysis. The rate of electro-mechanical equipments has been workout as per the quotation issued by manufacturer.
After the detailed engineering designed was complete than the quantity and volume of work were worked out. The details of rate analysis and quantities of work are presented in the annex of this report.

4.2 Summary of Cost

The total cost estimation of the project has been carried out from the costing of mechanical works, electrical works, civil works, tools, spare parts, transportation cost, and installation, testing commissioning and contingency. The total project cost is Rs. 13,773,857.00. The cost per kW is Rs. 344,346.00. The detailed cost estimate of the project is presented in the annex of this report.

Table 10: Summary of Project Costs:

S.No	Description	T.Costs (NRs.)	Local (Rs.)	Non-Local (Rs.)	% of Total Cost
1.0	Site Clearance	3000.0	3000.0	0.0	0.02
2.0	Intake and Diversion	55,870	16,380	39,490	0.41
3.0	Settiling Basin	63,371	31,120	32,250	0.46
4.0	Headrace Canal	474,932	223,673	251,259	3.45
5.0	Forebay	146,669	66,214	80,454	1.06
6.0	Penstock, Support & Anchor Blocks	292,819	140,780	152,039	2.13
7.0	Power House	156,482	135,901	20,581	1.14
8.0	Machine Foundation	43,516	35,452	8,064	0.32
9.0	Tail Race Canal	29,446	14,792	14,654	0.21
10.0	Intake accessories	20,000	0	20,000	0.15
11.0	Forebay & Settling Basin accessories	37,500	0	37,500	0.27
12.0	Pipe accessories	1,429,200	0	1,429,200	10.38
13.0	Turbine & Power Transmission	564,000	0	564,000	4.09
14.0	Generator & Accessories	385,000	0	385,000	2.80
15.0	Protection System	882,000	0	882,000	6.40

16.0	Wiring	171,250	0	171,250	1.24
17.0	Conductor	2,243,734	0	2,243,734	16.29
18.0	Fittings	1,353,290	0	1,353,290	9.83
19.0	Poles	2,011,400	500,400	1,511,000	14.60
20.0	Transformer and Accessories	576,000	0	576,000	4.18
21.0	Packing & Transportation	474,919	0	474,919	3.45
22.0	Electro-mechanical Installation	355,000	0	355,000	2.58
23.0	Testing Commissoning	50,000	0	50,000	0.36
24.0	Tools and Spare Parts	47,280	0	47,280	0.34
	Sub Total	**11,866,677**	**1,167,712**	**10,698,964**	**86.15**
	13% VAT for Non Local Cost of Electro-Mechanical Components	**1,251,283**	**0**	**1,251,283**	**9.08**
	Total	**13,117,960**	**1,167,712**	**11,950,247**	**95**
	Contengencies	**655,898**	**58,386**	**597,512**	**4.76**
	Grand total	**13,773,857**	**1,226,098**	**12,547,759**	**100**
	Capacity	**40**	**kW**		
	Cost per kW	**344,346**			
	Cost per HH	**50,454**			

4.3 Financial Mix

For the implementation of this MHP, major source of finance will be provided by AEPC/ESAP as a subsidy. The total subsidy amount for the MHP will be Rs. 6,200,000.00 according to government policy of Rs. 125,000 per kW and Rs 30000 per kW for more than 70 Km, as transportation subsidy.

Besides, the community people would mobilize Rs. 1,226,098.00 through voluntary labor and local material contribution and remaining Rs. 2,383,374.00 would be mobilized from the bank and Rs. 2,587,000.00(Rs. 6500 per H/H) by the community cash contribution. Lastly, DDC and VDC investment would be Rs. 1,377,386 .00 (10% of Total Project Costs).

Table 11: Mobilization of Resources

Source of Finance:

S.N.	Sources	Amount (Rs)	Share (%)	Remarks
1	AEPC Subsidy (MH + Transportation Subsidy)	6,200,000	45.01	Rs.125000 per KW + Rs. 300 per km per kW transportation subsidy
2	Community Cash Contribution	2,587,000	18.78	6500/HH
3	Bank Loan	2,383,374	17.30	
4	(DDC+VDC) Investment	1,377,386	10.00	10% of Total Project Costs
5	Community Equity	1,226,098	8.90	Local Costs
	Total Source of Finance:	**13,773,857**	**100**	

4.4 Annual Expenses

The total annual expenses are tabulated below.

Table 12: Annual Recurring Expenses

S.N	Description	Amount (Annual), NRs	Remarks
1	Salary-Manager	54,000	4500/ month
2	Salary-Operator - 1	48,000	4000/ month
3	Salary-Operator - 2	48,000	4000/ month
4	Repair and Maintenance	413,216	3% of TPC
5	Office expenses	2,400	
6	Miscellaneous	2,400	
	Total	**568,016**	

4.5 Annual Incomes

Based on the investment required, annual expenses and other necessary provisions, tariff rate has been proposed herewith but this might have to be revised regularly to incorporate the changes in price and other relevant factors over time. Considering these, fixed tariff rate of Rs. 2.95 per watt per month for domestic lighting and Rs. 11.0 per kWh for end-use activities have been proposed for this scheme.

Table 13: Annual Income

Probalble Business									
S.N	Type of Business	Location	Power (kW)	Operatin g Hours	Operating Days / Month	Operating Months / Year	Total Energy Consumpt ion (kWh)	Tariff per kWh	Total Income
1	Agro-processing mill	Village	6	5	20	10	6000	11	66000
2	Bakery	Village	5	4	25	11	5500	11	60500
3	Rural Carpentry	Village	4	5	25	11	5500	11	60500
4	Computer Lab	Village	6	6	25	10	9000	11	99000
5	High Vision Hall	Village	3	3	10	12	1080	11	11880
6	Dairy Factory	Village	5	3	25	11	4125	11	45375
7	Cable TV Network	Village	4	5	25	11	5500	11	60500
						Total	**36705**		**403755**

4.6 Financial Analysis

This section of the report presents the brief cost analysis of the proposed scheme. The cost evaluation is undertaken to assess the economic viability (soundness) of the project. This will be useful to judge the project from the developer's and financial institution's perspective. The following parameters are considered for the cost analysis of the project.

- Capital Investment
- Construction Period
- Economic Life of the Project
- Running Cost Involved
- Revenues from the Project

The financial analysis of the scheme focuses on the source of funding for the project, annual income, annual loss, and financial indicator of the project such as Net Present Value, Benefit Cost Ratio, and Internal Rate of Return etc. The Financial Analysis Sheet has been attached in Annex V. Main financial indicators are presented below.

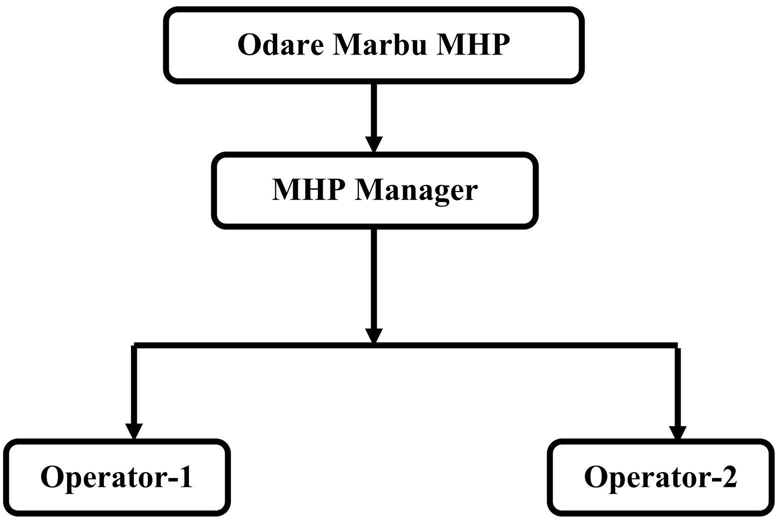
NPV at 10% (Discount Rate 6%) = 423978
IRR = 10.94 %
Pay Back Period = 7.0
Benefit Cost Ratio = 1.35

Chapter 5
OPERATION AND MANAGEMENT ASPECTS OF THE MHP

The success of a project depends on its operation and management. As the project itself is the property of the local people, so it is the responsibility of the local people to look after the project. Considerable benefits can be reaped from MHP if it is operated and managed properly. Neither the entrepreneurs nor the consumers will gain from the MHP that is not operated and managed properly. Prospective MHP entrepreneurs should bear in mind the aspects of operation and management i.e. management of daily operations, availability of operators and resource management.

The ownership type of the MHP is community owned. However, with no any experience as such in MHP, the manager and operators must be given training for the proper operation and maintenance of the MHP. The manager and the operator will be responsible for the daily operation and management of the MHP. The monitoring should be carried out regularly based on information collection, decision making from follow up and reports. A periodic reports and information received at different places in different intervals should be reviewed and evaluated.

Operational rules administered by the MHP should be provided for connection condition, collection of tariffs, fines for late and disconnection for non-payment. The manager will be responsible for ensuring timely payment of electricity bills by consumers and for dealing with tampering, theft etc. In order to monitor the activities and the participatory achievements at regular intervals, the reporting system will be devised in such a way that a coherent picture of the different activities would be emerge to the management in a timely manner.



Chapter 6
CONCLUSIONS AND RECOMMENDATIONS

From the preceding analyses and discussions, it is found out that the project is technically and financially feasible. The implementation of the project will provide high quality lighting for household purpose as well as reliable and environmentally safe power for end-use applications. The MHP will help in saving carbon annually due to the replacement of kerosene and diesel by micro hydro electricity.

As seen through the financial analysis, the NPV of the project is positive (6% discount rate, 15 years) with Payback period of 7.0 years, B/C ratio of 1.35 and IRR being 10.94%. Thus the project should be considered beneficial from all aspects viz. financially, environmentally and socially. The cost/kW of the proposed project is about 344,346.00.

During installation, it is highly recommended to involve only experienced parties or technicians.

Obviously, the socio-economical status of the village will be improved with the implementation of the project. Presently used resources to mitigate the lighting energy demand will be replaced by converting the water potential to electrical energy as discussed above. It will definitely reduce forest product consumption. After implementation of the scheme, there will several end uses like agro-processing mill, rural carpentry, bakery and battery charging etc and many more installations, which will automatically make life easier.

Thus the project is feasible and recommended for its construction.

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