Buwa Khola-I MHP (11 kW)

Detail Assessment Report of Buwa Khola-I MHP,
Aamchowk Rural Municipality, Bhojpur, Province 1

जर्मन सहयोग
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Buwa Khola-I MHP User's Committee | May 2019 | Final Report

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1.0 INTRODUCTION

For more than two decades, the Government of Nepal (GoN), together with various development partners, has been using subsidies as a tool to stimulate demand for off-grid renewable energy (RE) in the country. This fiscal tool coupled with community mobilization practices, helped the uptake of various renewable energy technologies (RETs) that have transformed the lives of millions of poor families by providing them cooking, lighting and other energy-induced income-generating solutions. Isolated RETs such as micro hydropower, can substantially improve the rural economy. Specifically, micro hydropower plants (MHPs) have been serving off-grid rural households in the hilly regions since they were introduced in Nepal in the 1960s. MHPs are contributing to uplift livelihoods of rural people particularly in off-grid areas and opening-up other avenues for economic activities. However, it has been realized that the promotion of decentralized RE strongly depends on subsidies and has largely been unable to establish sustainable markets for these technologies. Lack of involvement of local authorities and end-users in RE planning, unfavourable conditions for private sector investment, insufficient supply relations between technology providers and end-users, lack of access to finance, and inadequate after-sale-services are some of the reasons that lead to the absence of sustainable markets.

Renewable Energy for Rural Areas (RERA) programme aim on improving and developing a framework for participatory and demand-led promotion of small-scale RE in central, provincial, and local government authorities, and ensuring the effective cooperation with civil society and the private sector in the context of federalization and constitutional reform. More specifically, the ultimate expected outcome of RERA is that more people have access to modern and high-quality energy services, people and energy enterprises have a better access to finance, local markets for energy services and products are strengthened, and the private sector expands its activities. And in addition, women and disadvantaged groups are involved in planning and decision-making processes for government energy programs and are equally benefitting from energy services.

Renewable Energy for Rural Areas (RERA) is a joint technical support programme by the GoN and the German Federal Ministry for Economic Cooperation and Development (BMZ). RERA is jointly implemented by Alternative Energy Promotion Center (AEPC) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

2.0 BACKGROUND

The RERA programme is supporting federalization in the RE sector and works with federal, provincial and local governments, as well as with the civil society, private and banking sector for improving the energy situation in Nepal. Amongst other measures, RERA supported AEPC in the setting up of two Project Implementation Unit (PIU) in Province 1 and Sudoorpaschim Province. Through these PIU, RERA supports the provincial governments of Province 1 and Sudoorpaschim to institutionalise RE as part of

the ministerial structure and to include RE in the government services delivered by the provinces. Through the PIU, RERA also closely works and supports partner municipalities in both the provinces.

The RERA programme supported in conducting the assessment of Buwa Khola-I MHP in Aamchowk Rural Municipality (one of the partner municipalities) in the Province 1. The MHP was not functioning properly and RERA identified necessary improvements in the civil, mechanical and electrical works of the project through a field assessment.

A team of experts visited the Buwa Khola-I MHP and assessed the present of the MHP which includes civil works, electro-hydro-mechanical parts, transmission/distribution lines, management structure, potentials for upgrading and grid interconnection.

This field survey's data shows that there is a huge decrease in power generation due to insufficient discharge. The quality of head works structure is very poor to convey design discharge. In the past, the project has been hit by lightning several times damaging the electrical components in the powerhouse. The field observations are listed below:

- leakages in the turbine,
- distribution lines and poles are not installed properly,
- construction of new anchor block headrace is necessary,
- canal needs partial reconstruction
- forebay needs complete plastering inside and outside,
- butterfly value not working and needs to be replaced,
- absence of lightning arrestor and corrosion on the meal parts of earthing,

3.0 ABOUT THE MHP

The Buwa Khola - I MHP project site lies south-west of the district head quarter. It takes three hours walking to reach the project site from the nearest road head at Balankha Bazaar. The topography and geography condition of the project site is found to be fairly stable. The topography of the project site lies in the Mahabharat range. No signs of major landslides and other instabilities were found during the site visit. The source of flow is Buwa Khola, which is a perennial stream and there are no major water right conflicts in this area for the source of water.

The Buwa Khola-I MHP is a community owned project. The gross water head of the scheme is 28 m and the design discharge 78 lps (litres per second) which results in a

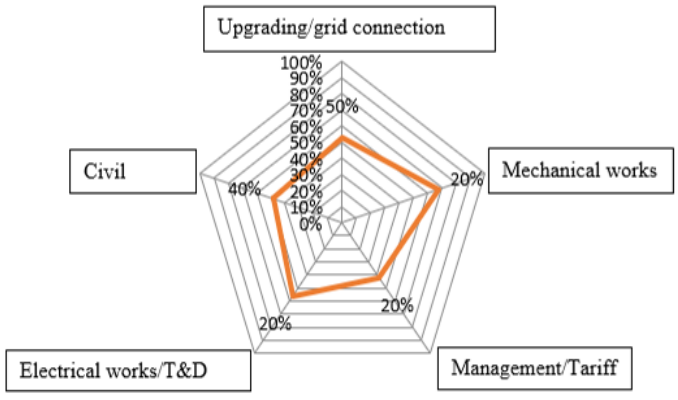

Figure 1: Graphical display (spider-web) of the present status of the plant

total power generation of 11 kW with an overall efficiency of 50 %. The scheme has been providing electricity to the 76 HHs of ward No. 4 of Aamchowk RM. The electricity generated is being utilized mostly for lighting purpose only. Altogether 92 households from the settlement were estimated to get benefits from the scheme after the MHP starts generating electricity. But due to recurring irregular electricity outages during the initial phase of operation, not all households were connected. Figure 1 indicates problems in different sub-systems, which lead to the plant not functioning to its full capacity. The tariff structures of the plant are not systematic and have hardly covered operation and maintenance costs. This can cause long to indefinite down-times whenever minor problems occur.

The salient features of the project are provided below:

Parameters	**Designed**
General Information	
Name of the Project	Buwa Khola- I MHP
Owner	Buwa Khola I MHP user committee
Installer	Krishna Grill and Engineering Works, Biratnagar
Technical Features	
Name of the Source	Buwa Khola
No of Households	87
Type of Intake	Side intake
Diversion	Temporary
Gross Head	28 m
Flow for Power Generation	78 lps
Power Output	11 kW
Measured flow by Intake	130.2 lps
Penstock pipe	Mild Steel pipe 220 mm ID, 3mm thickness 58 m long
Turbine	Crossflow Turbine, 17 kW Shaft Output
Generator	25 KVA, 50 Hz, 440V, 3 phase, 4 poles, 0.8 pf lagging, 1500 rpm
ELC	11 kW
Overall Efficiency	50 %
Head Race Canal	303 m, stone masonry, non-masonry and HDPE pipes
Load Controller	ELC extension 11 kW with ballast tank 14 kW
Distribution Lines	2 km - 3 phase weasel, 1.75 km - 3 phase squirrel, 500 m - single phase squirrel
Beneficiary Households (Nos)	92 designed (connected 76)
Project Construction Start Date	March 2009
Project Commissioned Date	July 2011

The figure attached here shows the Google Maps of the location of Buwa Khola-I MHP:

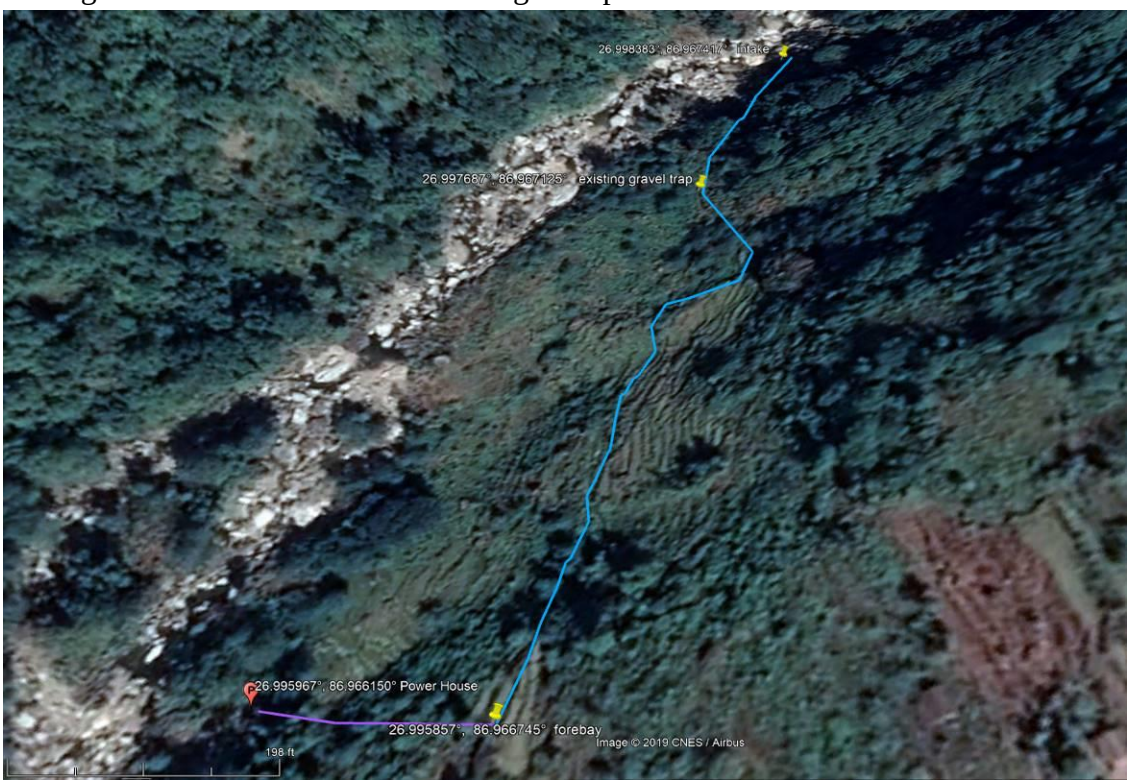

Figure 2: Google location of the project

4.0 OBJECTIVE OF THE STUDY

The major objective of the study was to carry out technical assessment of each components of the aforementioned MHP, listing up the shortcoming of each components and finalization of the bill of quantity for the rehabilitation of the MHP. The study also provides recommendations on improving the technical, financial and organizational management system of the project, improvement in insufficient tariff collection and decision on its utilization with significant progress in eliminating the lack of capacity development support and management skills of the project user committee members.

5.0 METHODOLOGY

The table below presents and summarizes various tasks activities carried out for the execution of the assignment in order to obtain some distinct outcomes in different phases of the assignment

Phases	**Tasks**
Phase I	1. Literature review 2. Preparation of checklist of questionnaires for information collection 3. Conduct field visit and collect information on the individual MHP components and its status

Phase II: Finalization of the bill of quantity	1. Review of the collected field data and prepare a detailed bill of quantity. 2. Discussion and feedback from RERA team members and finalization of ToC and BOQ 3. Interaction with user's committee and relevant stakeholders
Phase III: Assessment, analysis and report preparation	1. Verification and validation of the information/data obtained 2. Assessment and analysis of data /information 3. Draft report preparation with recommendation for rehabilitation possibilities
Phase IV: Finalization of the report	1. Incorporation of feedback from RERA team 2. Finalization of the report

Table 1: Phases of the assignment

6.0 FINANCIAL SUMMARY FOR REHABILITATION

The summary of final BOQ of Buwa Khola-I MHP has been presented in the table below

Summary of Cost				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
A	Civil Works	1,741,875	1,125,173	655,784
B	Mechanical Cost	85,000	-	85,000
C	Electro-Mechanical Cost	751,167	-	751,167
D	Other Cost	335,000	80,000	255,000
	Total	**2,913,041**	**1,205,173**	**1,746,951**
A. CIVIL WORKS				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
1	Intake and Weir Structure	101,971	75,685	26,286
2	Headrace Cannel	870,306	534,786	335,520
3	Fore Bay	130,010	76,278	53,732
4	Spillway at Forebay	67,889	38,759	29,129
5	Support Piers and Penstock Alignment	427,338	304,345	122,993
6	Power House	70,994	46,570	63,507
7	Tailrace	73,368	48,751	24,617
	Total A (Civil Cost)	**1,741,875**	**1,125,173**	**655,784**
B. MECHANICAL COMPONENT				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
1	Butterfly Valve, 150 mm dia., Gear Operated	75,000		75,000
2	Pressure Gauge	10,000		10,000

	Total B (Mechanical Cost)	**85,000.00**	**-**	**85,000.00**
C. ELECTRO-MECHANICAL COMPONENT				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
1	Protection system	144,250		144,250
2	Conductor	31,583		31,583
3	wiring	5,000		5,000
4	Fittings	48,000		48,000
5	Poles and stay set	522,333		522,333
	Total C (Electro-Mechanical Cost)	**751,167**	**-**	**751,167**
D. OTHER COST				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
1	Tools	5,000		5,000
2	Spare Parts	73,333		73,333
3	Transportation	160,000	80,000	80,000
4	Installation, Supervision and Commissioning	96,667		96,667
	Total D (Other Cost)	**335,000**	**80,000**	**255,000**

Table 2: Detailed breakdown of the cost [in NRP]

7.0 RECOMMENDATION FOR PROJECT SUSTAINABILITY

7.1 Financial Dimension

7.1.1 Financial Analysis Overview

A financial analysis was carried out to assess the viability and sustainability of the project. The financial analysis involved detail financial assessment starting from project assumptions to financial evaluation of the project considering the rehabilitation cost, revenue structure and mechanism and Operation and Maintenance (O&M) Cost.

7.1.2 Rehabilitation Cost Summary

The summary of the rehabilitation cost is as follows:

Summary of Cost				
S.N	**Description**	**Total Cost**	**Local Cost**	**Non-Local Cost**
A	Civil Works	1,741,875	1,125,173	655,784
B	Mechanical Cost	85,000	-	85,000
C	Electro Mechanical Cost	751,167	-	751,167
D	Other Cost	335,000	80,000	255,000
	Total	**2,913,041**	**1,205,173**	**1,746,951**

Table 3: Summary of the rehabilitation cost [in NRP]

7.1.3 Operational Expenditure (OPEX) Overview

Operating costs are expenses associated with the maintenance and administration cost of the project after commissioning of the project on a day-to-day basis. Generally, in micro hydro operational expenses accounts to cost of labour, administrative costs and general repair and maintenance.

The table below shows the assumed operational expenditures of Buwa Khola-I MHP.

Cost	**Monthly**	**Annually**
Operator Cost	9,000.00	108,000.00
Manager Cost	3,000.00	36,000.00
Maintenance Cost	16,667.00	200,000.00
Total O&M Cost	28,667.00	344,000.00

Table 4: O&M cost [in NRP] of the project

7.1.4 Revenue Analysis

Revenue in MHP are generally affected my number of factors. Major factor affecting the revenue is the annual energy yield; hence accurate energy yield predications are critical. For Buwa Khola-I MHP the following revenue assumptions are made.

7.1.4.1 Option 1 (Household Base Model)

Currently, the model listed below, is used to collect the revenue:

Connected Households (Nos)	75
Tariff/HH/month (NPR)	150.00
Monthly Revenue (NPR)	11,250.00
Yearly Revenue (NPR)	135,000.00

7.1.4.2 Option 2 (Tariff Base Model)

The financial analysis was carried out to analyse tariff-based models for the revenue collection. The details of this mechanism are listed below:

Tariff / kWh (NPR)	5.61
Annual Energy Generation at 7 kW Capacity (kWh)	61,320.00
Annual Revenue (NPR)	344,000.00

7.1.4.3 Option 3 (Household and Tariff based mixed model)

In this case it was assumed that the 75 households pay a fixed rate of 150 per month and additional revenues from the potential enterprises are assumed to contribute a part of revenue. The detail of household and enterprises revenue is listed in the table below:

Household Revenue

Connected Households (Nos)	Tariff/HH/month	Monthly Revenue (NPR)	Yearly Revenue (NPR)
75	150.00	11,250.00	135,000.00

Enterprises Revenue

S.N	End Use	kW	Operation hrs/day	Operation days/year	Total Energy	Amount @Rs.10/Unit
1	Computer Centre	3	8	330.00	7,920.00	79,200.00
2	Rural Bakery	3	5	330.00	4,950.00	49,500.00
3	Rural Municipality	1	5	300.00	1,500.00	15,000.00
4	Bank	1	5	300.00	1,500.00	15,000.00
				Total (NPR)		1,58,700.00

Total revenue from households and enterprises = NPR 2,93,700.00

7.1.5 Financial Modelling

Financial modelling is a tool used for forecasting a projects financial performance. The forecast is typically based on the assumptions and simulation of defined variables. The output of a financial model is used for decision making and performing financial analysis.

The financial model estimates the key parameters that are needed to decide whether or not to proceed with the project.

Based on the financial analysis with the above assumptions for the project to be sustainable (i.e. at least revenue is equal to the O&M cost of the project). Following results are optioned as mentioned below:

7.1.5.1 Option 1 (Household Base Model) Recommendation

Revenue

Connected Households	75
Tariff/HH/month	382.22
Yearly Revenue	344,000.00

Expenses

O&M	**Monthly**	**Annually**
Operator Cost	9,000.00	108,000.00
Manager Cost	3,000.00	36,000.00

Maintenance Cost	16,667.00	200,000.00
Total O&M Cost	28,667.00	344,000.00

In this case it is observed that the household tariff should be NPR 382.22, monthly, to meet the O&M cost of the project.

7.1.5.2 Option 2 (Tariff Based Model) Recommendations

Revenue

Tariff / kWh	5.61
Annual Generation kWh on operation of 7 kW capacity	61,320.00
Annual Revenue	344,000.00

In this case it is observed that the tariff should be NPR 5.61/ kWh to meet the O&M cost of the project if the plan runs in an average of 7 KW capacities throughout the year.

7.1.5.3 Option 3 (Household and Tariff based mixed model)

Household Revenue

Connected Households (Nos)	Tariff/HH/month	Monthly Revenue	Yearly Revenue
75	205.88	15,442.00	185,300.00

Enterprises Revenue

S.N	End Use	kW	Operation hrs / day	Operation days/year	Total Energy	Amount NPR10/Unit
1	Computer Centre	3	8	330.00	792.000	79,200.00
2	Rural Bakery	3	5	330.00	4,950.00	49,500.00
3	Rural Municipality	1	5	330.00	1,500.00	15,000.00
4	Bank	1	5	330.00	1,500.00	15,000.00
					Total	1,58,700.00

Total Revenue from household and enterprises = NPR 344,000.00

In this case it is recommended that the household tariff should be increased to around NPR 205 per month to meet all the operational expenses also assuming that productive uses of energy tariff would remain NPR 10 per unit.

7.1.6 Sensitivity Analysis

Sensitivity Analysis is a process of recalculating outcomes under alternative assumptions to determine the impact of variable parameters. It serves to analyze the various risks to a

project subject to uncertain conditions. Sensitivity analysis in this case involves changing the inputs in the financial model to analyze how the cash flow of the project is impacted.

7.1.6.1 Case 1: Assuming number of households fixed and changes in household tariff rate

Revenue Mechanism: Household and Tariff based mixed model
Assumptions: Annual End User energy consumptions 15,870 kWh ~ NPR 10 /kWh
Number of households: 75
Variable Parameter: Household monthly tariff rate

Results:

The below table and figure represent the sensitivity analysis of net project cash flow with change in household rate. The unit price for end users is assumed to be NPR 10 per unit and total energy consumptions is assumed to be 15,870 kWh and household rate per month is increased from NPR 150 to 283 per month. It is observed that household rate at NPR 206 per month the revenue is nearly equals to the total expenses; hence net cash flow is zero. The household rate above NPR 206 per month the project cashflow return positive cash flow and assuming 20 years life period of the project. Similarly, considering household rate at NPR 283 per month produce just enough cash flow to payback the rehabilitation cost incurred of total NPR 1,746,951. The project IRR considering this case is 0% with a simple payback of 20 years. The sensitivity analysis is attached in the annex.

Operation Years after rehabilitation	Net Cashflow at Household Rate (NPR 150)	Net Cashflow at Household Rate (NPR 175)	Net Cashflow at Household Rate (NPR 206)	Net Cashflow at Household Rate (NPR 225)	Net Cashflow at Household Rate (NPR 283)
1	-50,300	-27,800	0	17,200	69,553
2	-51,809	-28,634	0	17,716	71,639
3	-53,363	-29,493	0	18,247	73,789
4	-54,964	-30,378	0	18,795	76,002
5	-56,613	-31,289	0	19,359	78,282
6	-58,311	-32,228	0	19,940	80,631
7	-60,061	-33,195	0	20,538	83,050
8	-61,863	-34,190	0	21,154	85,541
9	-63,719	-35,216	0	21,788	88,108
10	-65,630	-36,273	0	22,442	90,751
11	-67,599	-37,361	0	23,115	93,473
12	-69,627	-38,482	0	23,809	96,277
13	-71,716	-39,636	0	24,523	99,166
14	-73,867	-40,825	0	25,259	102,141
15	-76,083	-42,050	0	26,017	105,205
16	-78,366	-43,311	0	26,797	108,361
17	-80,717	-44,611	0	27,601	111,612
18	-83,138	-45,949	0	28,429	114,960
19	-85,632	-47,328	0	29,282	118,409
Total	**-1,263,378**	**-698,249**	**0**	**432,010**	**1,746,951**

Table 5: Sensitivity analysis of project net cashflow w.r.t to monthly household rate

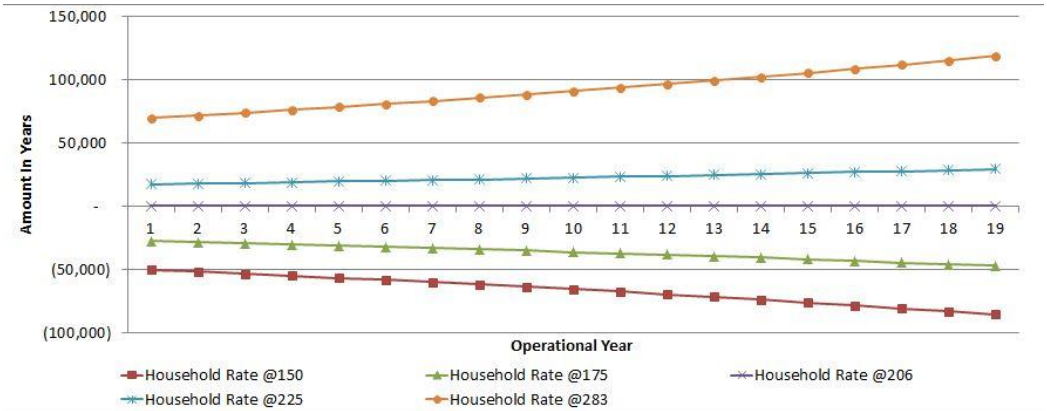

Figure 3: Sensitivity of net cashflow of project with changes in household rate

7.1.6.2 Case 2: Assuming number of household increment and changes in household tariff rate

Revenue Mechanism: Household and Tariff based mixed model
Assumptions: Annual energy consumptions 15,870 kWh ~ NPR 10/ kWh
Variable Parameter: Household monthly tariff rate and number of households

Results:

The below table represent the sensitivity analysis of net project cash flow for first year of operation with change in household rate and 75 households. The unit price for beneficiaries is assumed NPR 10 per unit and total energy consumptions is assumed to be 15,870 kWh. The sensitivity analysis carried out for the net project cash flow with increase in households number from 75 to 100 results in change in tariff rate from NPR 130 to 283 per month respectively.

It is observed that for 75 households rate at NPR 206 per month, revenue is slightly equal to total expenses. Similarly, for 90 households considering tariff of NPR 175 per month will nearly meet the operational expenses with NPR 3700 savings per month. In order to maintain the tariff at NPR 150 per month the minimum households connection should be consider to be 100 households.

No of Households	Monthly Household Tariff Rate (NPR/month)				
	150	175	206	225	283
75	-50300	-27800	0	17200	69400
80	-41300	-17300	12353	30700	86380
85	-32300	-6800	24707	44200	103360
90	-23300	3700	37060	57700	120340
95	-14300	14200	49413	71200	137320
100	-5300	24700	61767	84700	154300

Table 6: Sensitivity analysis of net cashflow w.r.t households and tariff rate

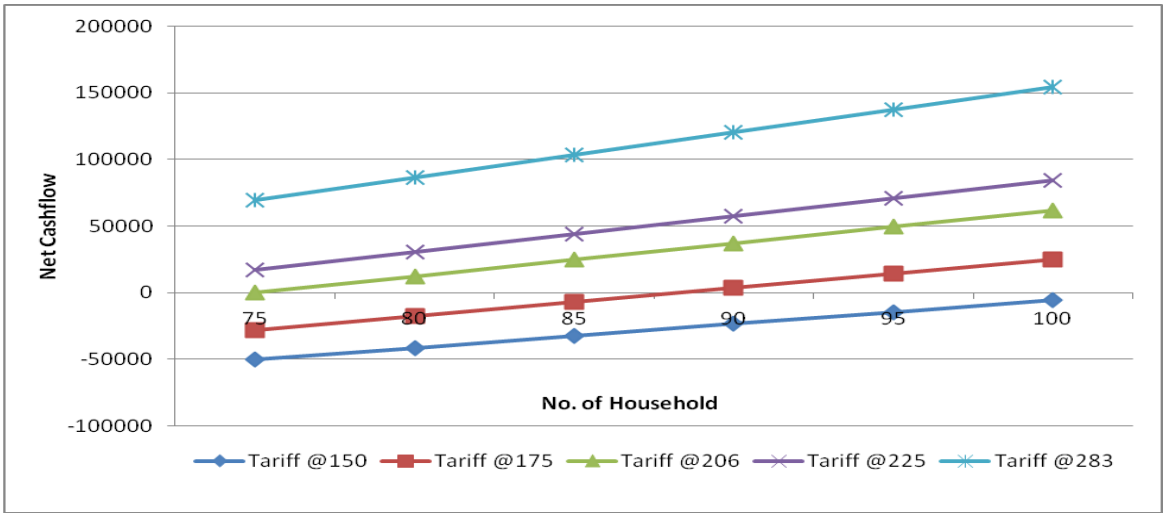

Figure 4: Sensitivity of net cashflow of project with changes in household

The below figure represents the sensitivity analysis of net project cash flow with change in household rate. This sensitivity analysis is run for Option 3 (Household and Tariff based mixed model). The unit price for productive uses of energy is assumed to be NPR 10 per unit and household rate per month is gradually increased from NPR 150.00 to 283.00 per month. It is observed that at a household rate of NPR 206.00 the revenue is just equal to the total expenses, and hence the net cashflow is zero. At a household rate above NPR 206.00 the project cashflow turns positive and assuming 20 years life period of the project it is observed that household rate of NPR 283.00 will slightly produce enough cash flow to pay back the incurring rehabilitation cost.

7.2 Social/Organizational Dimension

In this section, suggestions have been given on appropriate measures from the good governance and management aspects of the project based upon the information from the concerned project person and user's committee representative.

7.2.1 Participation of Community in Decision Making

Observing the current practice, it has been found that the decision-making process that the management team has been practicing is satisfactory. Small decisions are made after having discussions among executive members and for big decisions, there is involvement of the beneficiaries from all households. However, the committee meetings are irregular and are conducted as and when required.

Hence, it is recommended that in order to involve the beneficiaries in the decision-making process, periodic meetings involving their representatives and the management team should be conducted and the minutes documented and recorded. In addition, there should be introduction of the practice of having capacity building trainings to the community or the management committee regarding the project.

7.2.2 Financial Management

The survey showed that there is absence of any financial and other operational guidelines prepared for the project. Financial record keeping is very poor and a financial audit has not been done in the last two years. The manager is responsible for collecting tariffs from the users, however collected revenue have not been deposited in the bank account but paid to the staff directly. Hence no bank transaction has been done in the last year. As per the committee member the reason for not conducting financial audits is the lack of fund for the auditing process as the project is running in loss and facing challenges to even pay the salary to the staff.

Some rules have been set out regarding the penalty and charges for the beneficiaries not paying the tariff on time but so far have not been implemented.

It is recommended that documents like financial guidelines, project operational manuals should be prepared and circulated among the beneficiaries. The documents prepared therein should be systematic and realistic and the documents would need to be reviewed and revised periodically.

7.2.3 Financial Accountability and Transparency

The committee has been taking the responsibility for managing financial expenditure of the project collectively, but financial transparency is entirely absent in the process. The collected tariffs from beneficiaries are not deposited in the bank account but spend directly as staff salaries. The bank account dormant for the last one-year highlights poor governance systems including lack of accountability and transparency among the management committee

It is recommended that in order to maintain the financial transparency of the project, periodic financial reports should be prepared in a timely manner. The report thus prepared should be circulated within the stakeholders. The committee should make sure that the financial reports are legally audited and socially accepted.

On the other hand, a member of the committee should be given the responsibility of tracking and managing service quality to the end users in terms of hours of power supply and information dissemination in case of line interruptions. This member who shall also be responsible to prepare safety norms and define safety measures to be taken.

7.2.4 Tariff

A flat tariff of NPR 150 per household was set seven years ago on a mutual agreement of the project beneficiaries. However, the tariff rate has not been revised, since. Additionally, the committee members are unable to discuss the revision of tariff structures with the

consumers as the consumers are not happy with the quality and reliability of power supply. Tariffs are collected every three months and till date households have paid the tariff regularly.

Since the project is in loss, it is seen that it is of urgent importance for the tariff rate set seven years ago, to be revised and substituted by a practical tariff rate based upon mutual consent of project beneficiaries and committee members. To operate the MHP plant in a more sustainable manner the current tariff from NPR 150 per household and month must increase. Different operable tariff structures have been outlined and analysed above in Chapter 6.0. Similarly, the quality of the power supply and reliability needs to be improved.

7.2.5 Women Awareness/Participation

Among the 11 executive committee members, five are female which indicates significant inclusion of women in the management committee and ultimately in the decision-making process of the project.

There are instances, however, where the project has been lacking in providing knowledge and training to the women and beneficiaries regarding safety hazards. In one instance three female community members got injured due to a lightning strike while grinding crops in stone grinder (jaato in Nepali) in a house close to electricity line which lacks a proper earthing system. It has been realized that, besides technical upgrading as protection measure from lightning there is also need for awareness raising on electrical safety measures to the beneficiaries and especially to the women and children who have less knowledge and access to information regarding electrical safety and hazards.

7.2.6 Commercial Operation of MHPs

The sustainability of the MHP is a major issue requiring serious attention. The main reason behind this is the weak cash-flow performance of MHP and the poor governance structure. To ensure the sustainability of Buwa Khola-I MHP and to increase the attractiveness of the project, it should be operated and managed through a business perspective. The consumers and potential entrepreneurs need to be reoriented towards a commercial operation model. Local enterprises development will also include potential to prompt other local economic activities. Awareness creation among the beneficiaries, regarding productive energy use applications, is a must for realizing the full economic potential/benefits at local level. The following models can be adopted to shift MHP as a "social service" to "commercial operation".

7.2.6.1 Cooperative Model

In this model the existing management committee is dissolved and the MHP users are registered at the Cooperative Office and operate under the cooperative acts and bylaws. It

ensures local communities' participation, ownership and transparency for financial management. The cooperative model further cultivates good governance, ensure effective decision-making structure as well as bringing improvement in the management structure.

7.2.6.2 Private management model (Private Limited)

In this model, the present community management system is dissolved, and the ownership is based on a shareholder system. Individual shares will be distributed to all beneficiaries' households as per their interest and capacity to purchase the shares. This model is most suitable particularly at time of new MHP development. However, this model requires lengthy documentation process as per the Company Act of Nepal and takes more time. Furthermore, this model can be implemented more easily for new formed MHPs.

7.2.6.3 Leasing out Management of the Plant (Community owned Privately Managed)

This model for the O&M of the plant could be the most commercially viable model in MHPs. Under this model, the management ownership of the plant for a certain time-period is transferred to the potential individual entrepreneurs, private companies or others. The selected entrepreneur or company will be responsible for the O&M of the MHP for a certain period and subsequently handover the plant after completion of contractual agreement between both parties. The ownership of the plants lies within the user committee and the private entity makes its earning through the collection of tariffs from the beneficiaries. However, detail terms and condition will guide the operation of the plants. The terms and condition have to be developed with the support of legal expert. The challenge in this model will lie in establishing a functioning supervision of the Plant operator to guarantee not only profit maximization but also long-term technical sustainability through sound maintenance.

7.2.7 Governing Laws/Rules/Regulation/Policies and Provision of Compensation

No governing laws/rules/regulations/policies have been prepared and documented till date. There is no proper system or channel for the consumers to put ahead their concerns to the committee members. Till date, there is no provision of any compensation measures for the beneficiaries agreed or followed.

It is recommended that all the governing law/rules/regulation/policies of the project be prepared, documented and reviewed periodically and there should be proper channel for the consumers to put ahead their concerns to the committee members.

The figure below gives a brief overview of the actions recommended for the sustainability of the project;

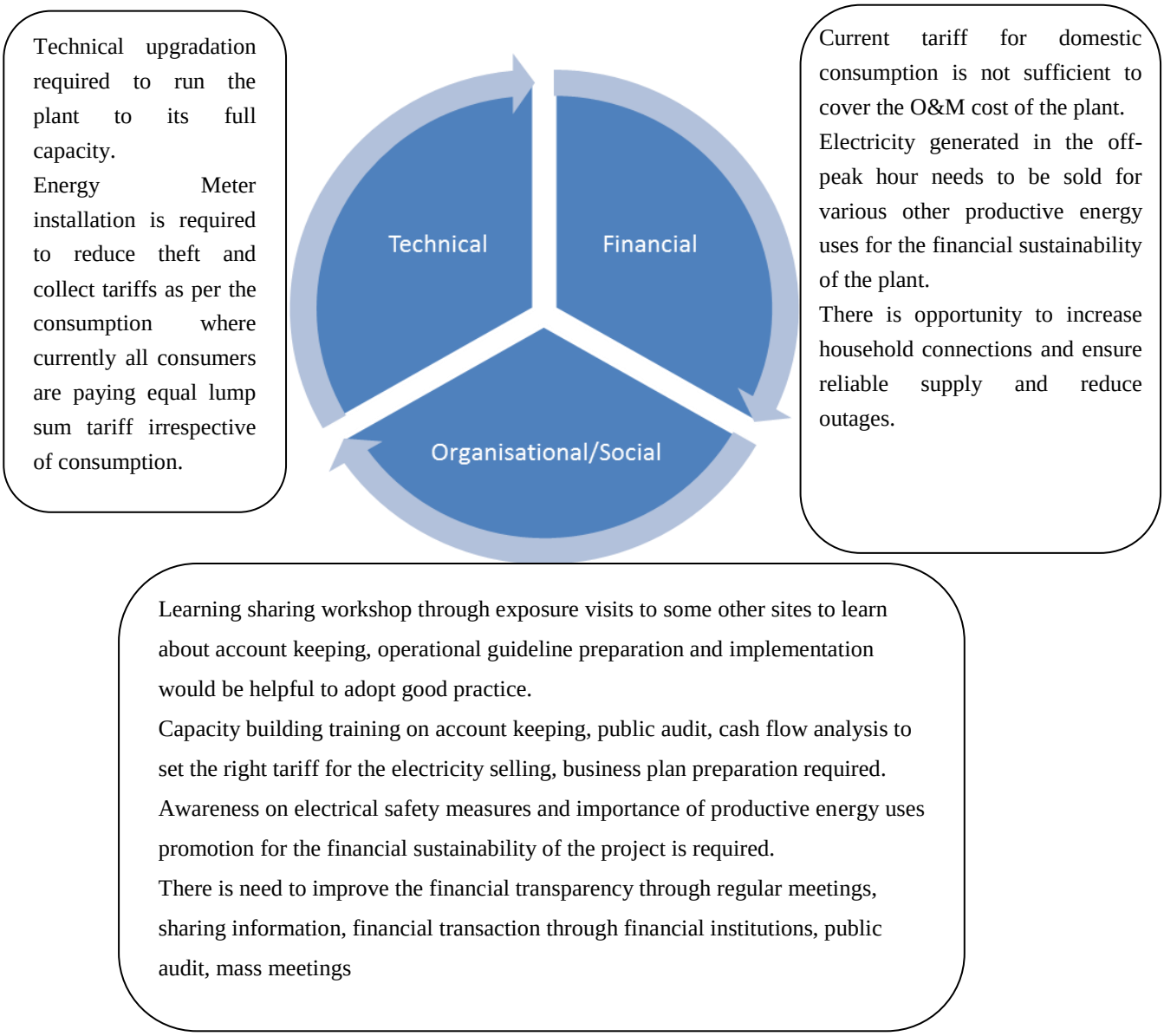

Figure 5: Actions recommended for the sustainability of the project

8.0 CONCLUSION

The study indicates that Buwa Khola-I MHP earnestly needs technical rehabilitation as well as a reform of its financial management and social organization. The project was initially designed for 11 kW, however due to insufficient discharge and with lots of flaws in construction work including civil, mechanical and electrical parts there is a huge decrease in power generation. The current tariff structures of the plants are not systematic and hardly able to finance O&M. Furthermore, low level of awareness on productive use of energy results in low tariff collection and increases the additional burden to operate the plant efficiently and steady.

Hence it can be stated that technical upgradation would enable the project to enhance the capacity of production of energy. This will also to improve the quality and reliability of

power supply which will help user committee to increase the tariff and to be financially sustainable. For operating the plant in sustainable manner, it is suggested to increase the tariff. This will ensure reliability of service and increase the willingness of users to pay more as they would receiver a higher quality energy supply.

Other aspects that need to be addressed are empowering MHP management by filling knowledge gaps among the committee members. This can be achieved by providing capacity building activities and trainings on account management system, business plan development as well other managerial aspects of operating MHP in a commercial way. This will help to improve the financial soundness of the Buwa Khola-I MHP and help to increase the plant load factor which will result in a positive long-term impact on the energy supply and hence living condition of the Buwa Khola community.

Annexes:

Annex 1: Cost Estimation

A CIVIL COMPONENTS

1. Intake and Weir Structure

S. N.	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1.0	E/W in excavation	6.72	m^3	524.00	3,521.28	3521.28	0.00
2.0	Dry Boulder Soling	0.55	m^3	3,117.00	1,701.88	1701.88	0.00
3.0	Gabion Works	14.00	m^3	6,910.56	96,747.81	70462.00	26285.81
				Total	**101,970.97**	**75,685.16**	**26,285.81**

2. Headrace Canal

S. N.	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1.0	E/W in excavation	60.00	m^3	524.00	31,440.00	31440.00	0.00
2.0	Dry Boulder Soling	24.00	m^3	3,117.00	74,808.00	74808.00	0.00
3.0	PCC in 1:2:4	12.00	m^3	14,464.60	173,575.20	84792.00	88783.20
4.0	Stone Masonary in 1:4 c/s mortar	32.40	m^3	13,507.17	437,632.31	264384.00	173248.31
5.0	Cement Plaster in 1:4 c/s	145.80	m^2	379.07	55,267.68	38106.29	17161.39
6.0	Gabion Works	30.00	m^3	2,180.56	65,416.73	9090.00	56326.73
7.0	Dry Stone Masonary work for HDPE crossing	4.50	m^3	4,460.00	20,070.00	20070.00	0.00
8.0	HDPE Pipe laying work	75.00	m	161.28	12,096.08	12096.08	0.00
				Total	**870,305.99**	**534,786.36**	**335,519.62**

3.Forebay Cum Desilting Basin

SN	Description of work	Qty	Unit	Rate	Amount (NRs.)	Local Cost	Non Local Cost
1	Site clearance		LS		-	-	-
2	Earthwork in excavation	17.78	Cu. m	524.00	9,316.72	9,316.72	0.00
3	100 mm PCC (1:2:4)	1.27	Cu. m	14,464.60	18,370.04	8,973.82	9,396.22
4	300 mm stone soling	3.81	Cu. m	3,117.00	11,875.77	11,875.77	0.00
5	Stone masonry 1:4 c/m	5.32	Cu. m	13,507.17	71,793.99	43,372.44	28,421.55
6	RCC (1:2:4)	0.10	Cu. m	19,541.40	1,954.14	877.98	1,076.16
7	Plastering in 1:4 c/m	7.12	Sqm.	379.07	2,698.94	1,860.88	838.06
8	Fine Trash rack (1000 mm x 800 mm)	1.00	No.	5,000.00	5,000.00	0.00	5,000.00
9	Stone Masonary in 1:4 c/s mortar	1.00	No.	6,000.00	6,000.00	0.00	6,000.00
10	50mm dia Air vent Pipe	1.00	No.	1,000.00	1,000.00	0.00	1,000.00
11	75mm dia drain Pipe	1.00	Set	2,000.00	2,000.00	0.00	2,000.00
	TOTAL				**130,009.60**	**76,277.61**	**53,731.99**

4. Spillway at Forebay

S. N.	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1.0	E/W in excavation	8.00	m^3	524.00	4,192.00	4,192.00	0.00
2.0	Dry Boulder Soling	3.00	m^3	3,117.00	9,351.00	3,117.00	6,234.00
3.0	PCC-1:2:4	1.00	m^3	14,464.60	14,464.60	7,066.00	7,398.60
4.0	Stone mansonry in 1:4 c/s mortar	2.70	m^3	13,507.17	36,469.36	22,032.00	14,437.36
5.0	Plastering in 1:4 c/s	9.00	m^2	379.07	3,411.59	2,352.24	1,059.35
				Total	**67,888.54**	**38,759.24**	**29,129.30**

5.Support Piers(for 47.4m+197m length of HDPE pipe at spacing of 2.5m)

S.N	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1	Earthwork in excavation	15	m3	524	7781	7781	0
2	300 mm stone soling	5	m3	3117	16159	16159	0
3	Stone masonry in 1:6 c/m	34	m3	11781	400782	279508	121274
4	PCC (1:3:6)	0.10	m3	16622	1616	897	719
5	Tarpolin Sheet		LS		1000		1000
				Total	**427,337.73**	**304,344.77**	**122,992.96**

6. Power House

S. N.	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1.0	Stone masonary in mud mortar (compaction works in crackS)	0.00	LS	5,000.00	5,000.00	5000.00	0.00
2.0	CGI sheet 26 gauge works including nails	39.20	m2	1,683.52	65,993.94	24010.00	41983.94
3.0	Turbine Generator baseframe foundation	2.00	m3	19,541.40	39,082.80	17559.60	21523.20
				Total	**70,993.94**	**46,569.60**	**63,507.14**

7. Tail Race

S. N.	Description of work	Quantity	Unit	Rate (NRs.)	Amount (NRs.)	Local Cost	Non Local Cost
1.0	E/W in excavation	10.00	m^3	524.00	5,240.00	5240.00	0.00
2.0	Dry Boulder Soling	3.00	m^3	3,117.00	9,351.00	9351.00	0.00
3.0	PCC 1:2:4	1.00	m^3	14,464.60	14,464.60	7066.00	7398.60
4.0	Stone Masonary with c/m-1:4	3.00	m^3	13,507.17	40,521.51	24480.00	16041.51
5.0	Plastering in 1:4 c/s	10.00	m^2	379.07	3,790.65	2613.60	1177.05
				Total	**73,367.76**	**48,750.60**	**24,617.16**

B MECHANICAL COMPONENTS

S.N	Particular	Qty	Unit	Rate(NRs.)	Amount(NRs.)
1.0	**Turbine**				
1.1	Pressure gauge	1.00	no	10,000.00	10,000.00
1.2	Butterfly Valve (220 mm ID)	1.00	no	75,000.00	75,000.00
				Sub-Total	**85,000.00**

C. ELECTRICAL COMPONENTS

1.0	**Protection system**				
1.1	Ballast Voltmeter	3.00	no	916.67	2,750.00
1.2	Load Ammeter	3.00	no	916.67	2,750.00
1.3	Main Switch 25 A	1.00	set	12,500.00	12,500.00
1.4	MCCB 25 A	1.00	no	12,333.33	12,333.33
1.5	Salt, Coal, Butimen paint etc	1.00	LS	21,000.00	21,000.00
1.6	Earthing Set: Copper Plate (600x600x3)mm 8 SWG copper wire	8.00	no	10,566.67	84,533.33
1.7	0.5 kV Lightening Arresstors	8.00	no	933.33	7,466.67
1.8	Frequency meter	1.00	no	916.67	916.67
				Sub-Total	**144,250.00**
2.0	**Conductor**				
2.1	ACSR Conductor Squirrel	0.500	km	26,833.33	13,416.67
2.2	ACSR Conductor Weaseal	0.500	km	36,333.33	18,166.67
				Sub-Total	**31,583.33**
3.0	**Wiring**		**LS**	**5000**	**5,000.00**
4.0	**Fittings**				
4.1	Shackle Insulator with D iron (Medium Sized)	200	no	240	48,000.00
				Sub-Total	**48,000.00**
5.0	**Poles**				
5.1	MS Pole 7 m height approx 72 kg 6m 4" dia and 1 m 3" dia	40.00	no	10558	422,333.33
5.2	Stay Set Assembly	40.00	set	2500	100,000.00
				Sub-Total	**522,333.33**

D. OTHER COST

1. TOOLS					
1.0	Tool Box (Slide wrench 10", a set of spanner for all size of nuts and bolts on turbine generator, penstock and other equipments, screwdriver set (small, medium, large), line tester, grease gun and digital clamp meter	1.00	no	5,000.00	5,000.00
				Sub-Total	**5,000.00**
2. SPARE PARTS					
1.0	Spare parts (Turbine, Generator bearings , HRC Fuse, Thyristers e.t.c)	1.00	LS	73,333.33	**73,333.33**
				Sub-Total	**73,333.33**
3. TRANSPORTATION					
1.0	Up to road head	L.S			80,000.00
2.0	Up to site	L.S			80,000.00
				Sub total	**160,000.00**
4. INSTALLATION/ TESTING & COMMISSIONING					
1.0	Installation works including transmission line erection	1.00	LS	96,667	96,666.67
				Sub-total	**96,666.67**
Grand Total					**335,000.00**

Civil Quantity Estimate

A. CIVIL COMPONENTS

1. Weir/ Intake Structures

S. N.	Description of Work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	E/W in excavation	1	14.00	1.20	0.40	6.72	m^3	
2.0	Dry Boulder Soling	1	1.30	1.40	0.30	0.55	m^3	
3.0	Gabion Works	1	14.00	1.00	1.00	14.00	m^3	
					Sub total	**21.27**	**m^3**	

2. Headrace canal

S. N.	Description of Work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	E/W in excavation	1	120.00	1.00	0.50	60.00	m^3	
2.0	Dry Boulder Soling	1	120.00	1.00	0.20	24.00	m^3	
3.0	PCC in 1:2:4	1	120.00	1.00	0.10	12.00	m^3	
4.0	Stone Masonary in 1:4 c/s mortar	2	120.00	0.30	0.45	32.40	m^3	
5.0	Cement Plaster in 1:4 c/s	2	162.00	0.45		145.80	m^2	
6.0	Gabion Works	1	10.00	1.00	3.00	30.00	m^3	
7.0	Dry Stone Masonary work for HDPE crossing	1	15.00	0.30	1.00	4.50	m^3	
8.0	HDPE Pipe laying work	1	75.00			**75.00**	**m**	

3. Forebay Cum Settling Basin

S.N	Description of work	No	L (m)	B (m)	H (m)	Quantity	Unit	Unit
1.0	Earthwork in excavation	1	12.70		1.40	17.78	m3	Plan area = 13.18 m2
2.0	100 mm PCC (1:2:4)	1						
	a. Forebay	1	12.70		0.10	1.27	m3	
3.0	300 mm stone soling							
	a. Forebay	1	12.70		0.30	3.81	m3	Plan area = 13.18 m2
4.0	Stone masonry in 1:4 c/m							
	i. Inlet Zone	2	1.40	0.38	0.64	0.67		
	ii. Central Zone	2	4.00	0.45	0.86	3.10		
	iii. Outlet Zone (Inlet Side)	1	1.00	0.45	0.86	0.39		
	iv. Outlet long side wall	1	2.60	0.45	0.90	1.05		
	v. Shortest wall	1	1.00	0.38	0.30	0.11		
						5.32	m3	
5.0	RCC Platform (1:2:4)	1	1.00	1.00	0.10	0.10	m3	
6.0	Plastering in 1:4 c/m							
	i) Side wall	1	4.32			0.00		
	ii) Short long wall	1	2.60		0.90	2.34		
	v) Top Surface	2	2.39			4.78		area=2.39
						7.12	Sqm.	
7.0	150 mm dia. MS flushing Cone	1					Set	
8.0	1000 mm x 800 mm fine Trashrack						Set	
9.0	75mm dia drain Pipe						Set	
10.0	50mm dia Airvent Pipe	1					Set	

4. Flushing of Forebay

S. N.	Description of Work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	E/W in excavation	1	10.00	1.00	0.80	**8.00**	m^3	
2.0	Dry Boulder Soling	1	10.00	1.00	0.30	**3.00**	m^3	
3.0	PCC-1:2:4	1	10.00	1.00	0.10	**1.00**	m^3	
4.0	Stone mansonry in 1:4 c/s mortar	2	10.00	0.30	0.45	**2.70**	m^3	
5.0	Plastering in 1:4 c/s	2	10.00	0.45		**9.00**	m^2	

5. Support Piers (for 47.4m +19.7 m length of HDPE pipe, at spacing of 2.5 m)

S.N	Description of work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	Earthwork in excavation	27	1.00	1.00	0.55	14.85	m3	
2.0	300 mm stone soling	27	0.80	0.80	0.30	5.18	m3	0
3.0	Stone masonry in 1:6 c/m	27	0.60	0.60	3.50	34.02	m3	
4.0	PCC (1:3:6)	3	0.60	0.60	0.10	0.10	m3	

6. Power House

S. N.	Description of Work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	Stone masonary in mud mortar							
2.0	CGI sheet 26 gauge works including nails		7.00	5.60		**39.20**	m^2	
3.0	Turbine Generator baseframe foundation					**2.00**	m^3	

7. Tail Race

S. N.	Description of Work	No	L (m)	B (m)	H (m)	Quantity	Unit	Remarks
1.0	E/W in excavation	1	10.00	1.00	1.00	**10.00**	m^3	
2.0	Dry Boulder Soling	1	10.00	1.00	0.30	**3.00**	m^3	
3.0	PCC 1:2:4	1	10.00	1.00	0.10	**1.00**	m^3	
4.0	Stone Masonary with c/m-1:4	2	10.00	0.30	0.50	**3.00**	m^3	
5.0	Plastering in 1:4 c/s	2	10.00	0.50		**10.00**	m^2	

Unit Rate of Materials and Labour at Aamchowk RM

Labour Rate

S.No.	Type	Unit	Rate,NRs.	Remarks
1	Skilled Labour	1 manday	950	1 manday = 8 hours
2	Unskilled Labour	1 manday	655	
3	Carpenter	1 manday	950	

Material

S.No.	Descriptions	Unit	Rate,NRs.	Remarks
1	Cement	1 Bag	1681.50	
2	Sand	1 cu. m.	2800.00	
3	Aggregates/Boulder (Course Agg)	1 cu. m.	2500.00	"
4	Stone	1 cu.m.	2000.00	"
5	Wood works	1 cu.ft.	400.00	Local forest
6	Low Quality wood	1 cu.ft.	200.00	"
7	C.G.I. Sheet(26 gauge) heavy	1 sqm	804.63	
10	Reinforcement bars	1 kg	114.96	
11	Binding Wire	1 kg	138.65	
12	Gabion wire	1 kg	137.55	
13	Salvage Wire	1 kg	137.55	
14	Nail	1 kg	106.63	
15	Pipe	1m		including nuts, bolts, washers
16	Welding M/C	1 Day	500.00	
17	Welding Rod	1 Pc	3.00	
18	Enamel	1 Ltr	260.00	

Rate of EM equipments

S.N	Description	Unit	Rate	
1	Pressure Gauge	no	10000	
2	Butterfly Valve (220 mmID)	no	75000	
3	Brushless Synchronous, 20 KVA, 400 V, 50Hz, 1500 RPM	set	280000	
4	Ballast Voltmeter	no	917	
5	Load Ammeter	no	917	
6	Main Switch 25 A	set	12500	
7	MCCB 25 A	no	12333	
8	Salt, Coal, Butimen paint etc	LS	21000	
9	Earthing Set: Copper Plate (600x600x3)mm 8 SWG copper wire	no	10567	
10	0.5 kV Lightening Arresstors	no	933	
11	ACSR conductor Squirrel	km	26833	
12	ACSR conductor Weasel	km	36333	
13	Shackle Insulator with D- Iron (Medium Sized)	no	240	
14	MS Pole 7 m height approx 72 kg 6m 4" dia and 1 m 3" dia	no	10558	
15	Installation works including transmission line erection	LS	96667	
16	Spare parts (Turbine, Generator bearings , HRC Fuse, Thyristers e.t.c)	LS	73333	
17	Stay set Assembly	set	2500	
18	Tool Box (Slide wrench 10", a set of spanner for all size of nuts and bolts on turbine generator, penstock and other equipments, screwdriver set (small, medium, large), line tester, grease gun and digital clamp meter	set	15333	

Annex 2: Sensitivity Analysis

I) Sensitivity Analysis at monthly household tariff rate NPR 150 and number of households 75

Financial Analysis
Buwa Khola

Input Value | Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M

	Monthly	Annually
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation

	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	75
Tariff/HH/month	150.00
Monthly Revenue	11,250
Yearly Revenue	135,000
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Choose Revenue Mechanism: 3 (1 : Option 1, 2 :Option 2, 3: Option 3)

Key Results

Project IRR	**#NUM!**
Project NPV	**(2,054,090)**
Simple Payback	**Dosen't Pay Back** years

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	75.00	150.00	293,700	(50,300)	(50,300)	(1,797,251)	1.00
3	-	354,320	15,870	10.30	75.00	154.50	302,511	(51,809)	(51,809)	(1,849,060)	1.00
4	-	364,950	15,870	10.61	75.00	159.14	311,586	(53,363)	(53,363)	(1,902,423)	1.00
5	-	375,898	15,870	10.93	75.00	163.91	320,934	(54,964)	(54,964)	(1,957,387)	1.00
6	-	387,175	15,870	11.26	75.00	168.83	330,562	(56,613)	(56,613)	(2,014,000)	1.00
7	-	398,790	15,870	11.59	75.00	173.89	340,479	(58,311)	(58,311)	(2,072,312)	1.00
8	-	410,754	15,870	11.94	75.00	179.11	350,693	(60,061)	(60,061)	(2,132,372)	1.00
9	-	423,077	15,870	12.30	75.00	184.48	361,214	(61,863)	(61,863)	(2,194,235)	1.00
10	-	435,769	15,870	12.67	75.00	190.02	372,050	(63,719)	(63,719)	(2,257,954)	1.00
11	-	448,842	15,870	13.05	75.00	195.72	383,212	(65,630)	(65,630)	(2,323,584)	1.00
12	-	462,307	15,870	13.44	75.00	201.59	394,708	(67,599)	(67,599)	(2,391,183)	1.00
13	-	476,176	15,870	13.84	75.00	207.64	406,549	(69,627)	(69,627)	(2,460,810)	1.00
14	-	490,462	15,870	14.26	75.00	213.86	418,746	(71,716)	(71,716)	(2,532,526)	1.00
15	-	505,176	15,870	14.69	75.00	220.28	431,308	(73,867)	(73,867)	(2,606,393)	1.00
16	-	520,331	15,870	15.13	75.00	226.89	444,248	(76,083)	(76,083)	(2,682,476)	1.00
17	-	535,941	15,870	15.58	75.00	233.70	457,575	(78,366)	(78,366)	(2,760,842)	1.00
18	-	552,019	15,870	16.05	75.00	240.71	471,302	(80,717)	(80,717)	(2,841,559)	1.00
19	-	568,580	15,870	16.53	75.00	247.93	485,441	(83,138)	(83,138)	(2,924,697)	1.00
20	-	585,637	15,870	17.02	75.00	255.36	500,005	(85,632)	(85,632)	(3,010,329)	1.00
Total	**1,746,951**	**8,640,203**					**7,376,824**	**(1,263,378)**	**(3,010,329)**		

II) Sensitivity Analysis at monthly household tariff rate NPR 175 and number of households 75

Financial Analysis
Buwa Khola

Input Value | Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M

	Monthly	Annually
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation

	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	75
Tariff/HH/month	175.00
Monthly Revenue	13,125
Yearly Revenue	157,500
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Choose Revenue Mechanism: 3 (1 : Option 1, 2 :Option 2, 3: Option 3)

Key Results

Project IRR	**#NUM!**
Project NPV	**(1,845,662)**
Simple Payback	**Dosen't Pay Back** years

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	75.00	175.00	316,200	(27,800)	(27,800)	(1,774,751)	1.00
3	-	354,320	15,870	10.30	75.00	180.25	325,686	(28,634)	(28,634)	(1,803,385)	1.00
4	-	364,950	15,870	10.61	75.00	185.66	335,457	(29,493)	(29,493)	(1,832,878)	1.00
5	-	375,898	15,870	10.93	75.00	191.23	345,520	(30,378)	(30,378)	(1,863,255)	1.00
6	-	387,175	15,870	11.26	75.00	196.96	355,886	(31,289)	(31,289)	(1,894,545)	1.00
7	-	398,790	15,870	11.59	75.00	202.87	366,562	(32,228)	(32,228)	(1,926,772)	1.00
8	-	410,754	15,870	11.94	75.00	208.96	377,559	(33,195)	(33,195)	(1,959,967)	1.00
9	-	423,077	15,870	12.30	75.00	215.23	388,886	(34,190)	(34,190)	(1,994,158)	1.00
10	-	435,769	15,870	12.67	75.00	221.68	400,553	(35,216)	(35,216)	(2,029,374)	1.00
11	-	448,842	15,870	13.05	75.00	228.34	412,569	(36,273)	(36,273)	(2,065,646)	1.00
12	-	462,307	15,870	13.44	75.00	235.19	424,946	(37,361)	(37,361)	(2,103,007)	1.00
13	-	476,176	15,870	13.84	75.00	242.24	437,695	(38,482)	(38,482)	(2,141,489)	1.00
14	-	490,462	15,870	14.26	75.00	249.51	450,826	(39,636)	(39,636)	(2,181,125)	1.00
15	-	505,176	15,870	14.69	75.00	256.99	464,350	(40,825)	(40,825)	(2,221,950)	1.00
16	-	520,331	15,870	15.13	75.00	264.70	478,281	(42,050)	(42,050)	(2,264,000)	1.00
17	-	535,941	15,870	15.58	75.00	272.64	492,629	(43,311)	(43,311)	(2,307,312)	1.00
18	-	552,019	15,870	16.05	75.00	280.82	507,408	(44,611)	(44,611)	(2,351,923)	1.00
19	-	568,580	15,870	16.53	75.00	289.25	522,630	(45,949)	(45,949)	(2,397,872)	1.00
20	-	585,637	15,870	17.02	75.00	297.93	538,309	(47,328)	(47,328)	(2,445,200)	1.00
Total	**1,746,951**	**8,640,203**					**7,941,954**	**(698,249)**	**(2,445,200)**		

III) Sensitivity Analysis at monthly household tariff rate NPR 206 and number of households 75

Financial Analysis

Buwa Khola

Input Value | Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M	**Monthly**	**Annually**
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation

	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	75
Tariff/HH/month	205.89
Monthly Revenue	15,442
Yearly Revenue	185,300
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Choose Revenue Mechanism: 3

1 : Option 1
2 :Option 2
3: Option 3

Key Results

Project IRR	**#NUM!**
Project NPV	**(1,588,137)**
Simple Payback	**Dosen't Pay Back** years

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	75.00	205.89	344,000	-	-	(1,746,951)	1.00
3	-	354,320	15,870	10.30	75.00	212.07	354,320	-	-	(1,746,951)	1.00
4	-	364,950	15,870	10.61	75.00	218.43	364,950	-	-	(1,746,951)	1.00
5	-	375,898	15,870	10.93	75.00	224.98	375,898	-	-	(1,746,951)	1.00
6	-	387,175	15,870	11.26	75.00	231.73	387,175	-	-	(1,746,951)	1.00
7	-	398,790	15,870	11.59	75.00	238.68	398,790	-	-	(1,746,951)	1.00
8	-	410,754	15,870	11.94	75.00	245.84	410,754	-	-	(1,746,951)	1.00
9	-	423,077	15,870	12.30	75.00	253.22	423,077	-	-	(1,746,951)	1.00
10	-	435,769	15,870	12.67	75.00	260.81	435,769	-	-	(1,746,951)	1.00
11	-	448,842	15,870	13.05	75.00	268.64	448,842	-	-	(1,746,951)	1.00
12	-	462,307	15,870	13.44	75.00	276.70	462,307	-	-	(1,746,951)	1.00
13	-	476,176	15,870	13.84	75.00	285.00	476,176	-	-	(1,746,951)	1.00
14	-	490,462	15,870	14.26	75.00	293.55	490,462	-	-	(1,746,951)	1.00
15	-	505,176	15,870	14.69	75.00	302.35	505,176	-	-	(1,746,951)	1.00
16	-	520,331	15,870	15.13	75.00	311.43	520,331	-	-	(1,746,951)	1.00
17	-	535,941	15,870	15.58	75.00	320.77	535,941	-	-	(1,746,951)	1.00
18	-	552,019	15,870	16.05	75.00	330.39	552,019	-	-	(1,746,951)	1.00
19	-	568,580	15,870	16.53	75.00	340.30	568,580	-	-	(1,746,951)	1.00
20	-	585,637	15,870	17.02	75.00	350.51	585,637	-	-	(1,746,951)	1.00
Total	**1,746,951**	**8,640,203**					**8,640,203**	**-**	**(1,746,951)**		

IV) Sensitivity Analysis at monthly household tariff rate NPR 225 and number of households 75

Financial Analysis

Buwa Khola

Input Value | Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M

	Monthly	Annually
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation

	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	75
Tariff/HH/month	225.00
Monthly Revenue	16,875
Yearly Revenue	202,500
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Choose Revenue Mechanism: 3 (1 : Option 1, 2 :Option 2, 3: Option 3)

Key Results

Project IRR	**-10.63%**
Project NPV	**(1,428,805)**
Simple Payback	**Dosen't Pay Back** years

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	75.00	225.00	361,200	17,200	17,200	(1,729,751)	1.00
3	-	354,320	15,870	10.30	75.00	231.75	372,036	17,716	17,716	(1,712,035)	1.00
4	-	364,950	15,870	10.61	75.00	238.70	383,197	18,247	18,247	(1,693,787)	1.00
5	-	375,898	15,870	10.93	75.00	245.86	394,693	18,795	18,795	(1,674,992)	1.00
6	-	387,175	15,870	11.26	75.00	253.24	406,534	19,359	19,359	(1,655,634)	1.00
7	-	398,790	15,870	11.59	75.00	260.84	418,730	19,940	19,940	(1,635,694)	1.00
8	-	410,754	15,870	11.94	75.00	268.66	431,292	20,538	20,538	(1,615,156)	1.00
9	-	423,077	15,870	12.30	75.00	276.72	444,230	21,154	21,154	(1,594,002)	1.00
10	-	435,769	15,870	12.67	75.00	285.02	457,557	21,788	21,788	(1,572,214)	1.00
11	-	448,842	15,870	13.05	75.00	293.57	471,284	22,442	22,442	(1,549,772)	1.00
12	-	462,307	15,870	13.44	75.00	302.38	485,423	23,115	23,115	(1,526,657)	1.00
13	-	476,176	15,870	13.84	75.00	311.45	499,985	23,809	23,809	(1,502,848)	1.00
14	-	490,462	15,870	14.26	75.00	320.80	514,985	24,523	24,523	(1,478,325)	1.00
15	-	505,176	15,870	14.69	75.00	330.42	530,434	25,259	25,259	(1,453,066)	1.00
16	-	520,331	15,870	15.13	75.00	340.33	546,347	26,017	26,017	(1,427,049)	1.00
17	-	535,941	15,870	15.58	75.00	350.54	562,738	26,797	26,797	(1,400,252)	1.00
18	-	552,019	15,870	16.05	75.00	361.06	579,620	27,601	27,601	(1,372,651)	1.00
19	-	568,580	15,870	16.53	75.00	371.89	597,009	28,429	28,429	(1,344,222)	1.00
20	-	585,637	15,870	17.02	75.00	383.05	614,919	29,282	29,282	(1,314,941)	1.00
Total	**1,746,951**	**8,640,203**					**9,072,213**	**432,010**	**(1,314,941)**		

V) Sensitivity Analysis at monthly household tariff rate NPR 225 and number of households 75

Financial Analysis
Buwa Khola

Input Value | Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M

	Monthly	Annually
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation

	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	75
Tariff/HH/month	283.17
Monthly Revenue	21,238
Yearly Revenue	254,853
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Choose Revenue Mechanism: 3 (1 : Option 1, 2 :Option 2, 3: Option 3)

Key Results

Project IRR	**0.00%**	
Project NPV	**(943,835)**	
Simple Payback	**20**	years

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	75.00	283.17	413,553	69,553	69,553	(1,677,398)	1.00
3	-	354,320	15,870	10.30	75.00	291.66	425,959	71,639	71,639	(1,605,758)	1.00
4	-	364,950	15,870	10.61	75.00	300.41	438,738	73,789	73,789	(1,531,970)	1.00
5	-	375,898	15,870	10.93	75.00	309.43	451,900	76,002	76,002	(1,455,967)	1.00
6	-	387,175	15,870	11.26	75.00	318.71	465,457	78,282	78,282	(1,377,685)	1.00
7	-	398,790	15,870	11.59	75.00	328.27	479,421	80,631	80,631	(1,297,054)	1.00
8	-	410,754	15,870	11.94	75.00	338.12	493,804	83,050	83,050	(1,214,004)	1.00
9	-	423,077	15,870	12.30	75.00	348.26	508,618	85,541	85,541	(1,128,463)	1.00
10	-	435,769	15,870	12.67	75.00	358.71	523,876	88,108	88,108	(1,040,356)	1.00
11	-	448,842	15,870	13.05	75.00	369.47	539,593	90,751	90,751	(949,605)	1.00
12	-	462,307	15,870	13.44	75.00	380.56	555,780	93,473	93,473	(856,132)	1.00
13	-	476,176	15,870	13.84	75.00	391.97	572,454	96,277	96,277	(759,854)	1.00
14	-	490,462	15,870	14.26	75.00	403.73	589,628	99,166	99,166	(660,688)	1.00
15	-	505,176	15,870	14.69	75.00	415.84	607,316	102,141	102,141	(558,548)	1.00
16	-	520,331	15,870	15.13	75.00	428.32	625,536	105,205	105,205	(453,343)	1.00
17	-	535,941	15,870	15.58	75.00	441.17	644,302	108,361	108,361	(344,981)	1.00
18	-	552,019	15,870	16.05	75.00	454.40	663,631	111,612	111,612	(233,369)	1.00
19	-	568,580	15,870	16.53	75.00	468.04	683,540	114,960	114,960	(118,409)	1.00
20	-	585,637	15,870	17.02	75.00	482.08	704,046	118,409	118,409	(0)	1.00
Total	**1,746,951**	**8,640,203**					**10,387,153**	**1,746,951**	**(0)**		

VI) Sensitivity Analysis at monthly household tariff rate NPR 171 and number of households 90

Financial Analysis

Buwa Khola

	Input Value		Output Value

General Parameter

Installed Capacity	11	KW
Present Operational Capacity	7	KW
Project Duration	20	Yrs

Rehabilitation Cost 1,746,951

O&M	**Monthly**	**Annually**
Operator Cost	9,000	108,000
Manager Cost	3,000	36,000
Maintenance Cost	16,667	200,000
Total O&M Cost	28,667	344,000

Annual Escalation on O&M 3% % of O&M

Energy Generation	Monthly	Annually
Plant Operation at 7KW Capacity	5,110.00	61,320.01

Revenue Mechanism

Option 1 (House Hold Base Model)

Connected Households	90
Tariff/HH/month	171.57
Monthly Revenue	15,442
Yearly Revenue	185,300
Annual Escalation	3.0%

Option 2 (Tariff Base Model)

Tariff/Kwh	5.61
Annual Revenue	344,000
Annual Escalation in tariff	3.0%

Option 3 (Household and Tariff Based Mix Model)

End User Tariff	10
End User Energy Consumtion	15870

Key Results

Project IRR	**#NUM!**
Project NPV	**(1,588,137)**
Simple Payback	**Dosen't Pay Back** years

Choose Revenue Mechanism: 3 (1 : Option 1, 2 :Option 2, 3: Option 3)

Year	Rehabilitation Cost NPR	O&M NPR	Annual Energy Kwh	Tariff NPR	No of house hold Nos	House Hold Rate/ Month NPR	Revenue NPR	Gross Operation Profit NPR	Net Cashflow	NPR	Payback Period Years
1	1,746,951								(1,746,951)	(1,746,951)	1.00
2	-	344,000	15,870	10.00	90.00	171.57	344,000	-	-	(1,746,951)	1.00
3	-	354,320	15,870	10.30	90.00	176.72	354,320	-	-	(1,746,951)	1.00
4	-	364,950	15,870	10.61	90.00	182.02	364,950	-	-	(1,746,951)	1.00
5	-	375,898	15,870	10.93	90.00	187.48	375,898	-	-	(1,746,951)	1.00
6	-	387,175	15,870	11.26	90.00	193.11	387,175	-	-	(1,746,951)	1.00
7	-	398,790	15,870	11.59	90.00	198.90	398,790	-	-	(1,746,951)	1.00
8	-	410,754	15,870	11.94	90.00	204.87	410,754	-	-	(1,746,951)	1.00
9	-	423,077	15,870	12.30	90.00	211.01	423,077	-	-	(1,746,951)	1.00
10	-	435,769	15,870	12.67	90.00	217.34	435,769	-	-	(1,746,951)	1.00
11	-	448,842	15,870	13.05	90.00	223.87	448,842	-	-	(1,746,951)	1.00
12	-	462,307	15,870	13.44	90.00	230.58	462,307	-	-	(1,746,951)	1.00
13	-	476,176	15,870	13.84	90.00	237.50	476,176	-	-	(1,746,951)	1.00
14	-	490,462	15,870	14.26	90.00	244.62	490,462	-	-	(1,746,951)	1.00
15	-	505,176	15,870	14.69	90.00	251.96	505,176	-	-	(1,746,951)	1.00
16	-	520,331	15,870	15.13	90.00	259.52	520,331	-	-	(1,746,951)	1.00
17	-	535,941	15,870	15.58	90.00	267.31	535,941	-	-	(1,746,951)	1.00
18	-	552,019	15,870	16.05	90.00	275.33	552,019	-	-	(1,746,951)	1.00
19	-	568,580	15,870	16.53	90.00	283.59	568,580	-	-	(1,746,951)	1.00
20	-	585,637	15,870	17.02	90.00	292.09	585,637	-	-	(1,746,951)	1.00
Total	**1,746,951**	**8,640,203**					**8,640,203**	**-**	**(1,746,951)**		

Annex 3: Photographs

Picture 1: Temporary weir

Picture 2: Crossing along the headrace cannel

Picture 3: Turbine generator of the project

Picture 4: Powerhouse