Chapter One

INTRODUCTION

1.1 Background:

Nepal has approximately 83,000 MW of hydropower potential of which about 43,000 MW is considered technically and economically feasible (WECS, 2002). As compared to this huge potential, present installed hydroelectric capacity in Nepal including the public sector and others is around 610 MW (about 1.3 percent of the total potential) including around 7 MW of micro-hydropower. Private operators have total installed capacity of 144 MW from which Nepal Electricity Authority (NEA) purchases power. Apart from large and medium sized hydropower plants, NEA has also 40 small hydro plants of which nine are grid connected (12.55 MW) and the rest (6.4 MW) are stand-alone plants (NEA, 2003). Statistics show that some 40 percent of the population, mostly in urban and semi urban areas, are estimated to have access to grid electricity and another 7 percent to some form of electricity through alterative energy sources (MOF, 2006).

It is estimated that the total energy consumption in 2000/01 was about 338 million Giga Joules (GJ) or 7,940 Tons Oil Equivalent (TOE), which comes around 14 GJ per capita energy consumption. In Nepal, traditional energy sources are the biggest contributors having their share of 86 percent in the total energy. These sources comprise of fuel wood (76%), and agriculture residues and animal waste (10%). Commercial energy sources share 13.64 percent leaving rest to other non-conventional sources. Electricity contributes about 1.2 percent of the total energy needs. If per capita energy consumption is any indicator of the status of industrial development of the country, Nepal has long way to go with around 60 KWH consumption per annum before coming close to industrialized countries where it is around 1,000 KWH (MOPE, 2003).

Hydropower development has potential to raise the contribution of electric energy in the total energy demand and thus relieve pressure on fuel wood, a principal cause of environmental degradation in Nepal. Various sectors of the economy - industrial, commercial, irrigation and others - require cheap and reliable energy for rapid development. Having no source of its own for fossil fuels but at the same time with high potential for hydropower, Nepal's almost entire energy demand could be met by the development of this clean energy source. His Majesty's Government of Nepal, therefore, has placed hydropower development as one of the top priorities in its development agenda.

Prior to 1960, all the hydropower stations were constructed through grant aid from friendly countries like the USSR (Panauti), India (Trishuli, Devighat, Gandak, Surajpura-Koshi) and China (Sunkoshi). Since 1970, hydropower development took a new turn with the availability of bilateral and multilateral funding sources. The major donor countries in the period were Japan, Germany, Norway, and South Korea, Canada, Finland, Denmark, Sweden and USA. The financial lending agencies were the World Bank, Asian Development Bank (ADB), Japanese Bank for International Cooperation (JBIC), Saudi Fund for Development, Kuwait Fund, and others. From the 1990s, subsequent to the adoption of the policy of economic liberalization, hydropower development took yet another turn with the private sector entering the arena. Government of Nepal, along with other relevant policy and regulatory reforms, approved Hydropower Policy 1992 in order to attract private sector investment in the sector. Private sector hydropower projects such as Khimti, Bhotekosi and Indrawati materialized as a consequence of introduction of that policy (Poudel, 2004).

Small-scale hydropower in Nepal is divided into micro-hydro (<100 kW), mini-hydro (0.1-1 MW), and small hydropower plants (1-10 MW). The small hydropower plants are usually connected to the national grid and are often privately financed and owned. Scaling-up small hydropower means to develop proper regulatory frameworks for independent power producers (IPPs) and to streamline the licensing and concessions systems for the use of water rights for power production and other competing purposes (irrigation, agricultural uses, potable water etc.) (Mostert, 1998).

As far as the technical feature of the micro hydro is concerned these schemes use water from the fast-flowing rivers that thunder down the Himalayan mountains. The water is diverted from the stream or river to drive a water turbine. Often the turbine drive belt is hooked to the drive shaft of a food-processing appliance, eg. to mechanically turn the grindstones to mill grain. The most common use of micro-hydro schemes is for agricultural processes, such as milling grain or de-hulling rice. Increasingly, there are some micro-hydro schemes that have been designed to produce electricity. In this scheme the water turbine drive belt is connected to a small generator or alternator to produce electricity.

Water turbines can also be used to generate electricity. The size of turbines and the amount of electricity that can be produced varies over a wide range. The main use of electricity in a rural community is for lighting as electric light is brighter and much easier to use than kerosene or vegetable oil. Electric light allows productive tasks to be done at night and students to study for much longer. However, it does not directly earn income and is only required for a few hours a day. So it can only use 19 to 29 per cent of the available energy from a hydroelectric plant. Other uses must be found for the rest of the energy.

Sixty-three of Nepal's 75 districts have potential for hydropower. With the help of INGOs since 1970s, Nepal has succeeded in building up an interesting manufacturing base capable of manufacturing or assembling all micro-hydropower components except the generators for micro-turbines up to 300 kW. The Government supported the development of micro-hydro on a stop-go basis through various technical and financial support programmes ever since the 1980s.Over the past few years, many villages in the mountainous areas that do not have access to the national grid have installed micro-hydro units. Lamjung is one of districts among the 63, having hydropower potential. Thus this study is based on "Bhujung Micro Hydro Electricity Project" that lies in Bhujung VDC of the district. It has been serving around 400 households since 2055 BS.

1.2 Statement of the Problem

Development of hydropower in Nepal is a very complex task as it faces numerous challenges and obstacles. Some of the factors attributed to the low level of hydropower development are: lack of capital, high cost of technology, political instability, lower load factor due to lower level of productive end-use of electricity and high technical and non–technical losses.

The household demand for electricity in the isolated communities and the ability and willingness to- pay for electricity are low. Household metering equipment is not installed in micro-hydro projects. Households pay according to the number of light bulbs they use or according to their demand for capacity - a fuse / cut-off device will typically limit the maximum demand of a household to 100 W. Monthly household charges are NRS 0.5-2 per W capacity, or RS 50-200 per month. This is far from enough to cover the cost of supply; and although projects receive substantial investment subsidies, the revenue is often insufficient to cover the cost of operation & maintenance and repairs and to repay loans received from ADB/N. In several projects, households refused to pay agreed monthly charges, once the investment had been made. The project promoters then felt forced to accept lower and loss-making monthly rates rather than no revenues.

Lack of knowledge in book-keeping and accounting is a problem, which is encountered in almost all micro-hydro projects, whether the plant is for agro-processing only or is used for household electrification. Revenue above the cost of operation and maintenance is regarded as profit and treated so.

No ownership model has come out as a clear winner. A clear lesson is that power companies such as NEA are not geared to handle micro-hydro projects. They think too big and too quality standard conscious during the design stage and their staff is too costly during the operation phase.

Individual entrepreneur ownership has the advantage of providing a productive demand for power with household electricity demand being an add-on. But it experiences more problems about water use rights and makes it more difficult to organize "free labor" for civil construction and for major repairs. Furnishing lighting to a larger group of customers must involve the engagement of the community in some manner, and a strong agent must be present to enforce rules.

Community ownership calls for a long, intensive period of community awareness building (one to two years) before any infrastructure investment is made. If, in addition, the community is ethnically heterogeneous, the task becomes "impossible". The ADB/N provides 5 to 7 years loans at 16 percent rate of interest to until 80 percent of the cost of micro-hydro projects.

ADB/N experiences problems with overdue loans in its loan portfolio to micro-hydro projects. The relatively richer and politically best-connected farmers have the worst repayment records.

Therefore, as summary from above it can be said that a number of factors that block a wider penetration of micro-hydro projects for the sustainable rural development can be summarized as follows:

- Lack of capital and awareness
- High cost of technology
- Political instability
- Lower load factor due to lower level of productive end-use of electricity
- High technical and non-technical losses
- Plants located at remote areas
- Poor economic condition of the rural people
- Lack of knowledge of bookkeeping and accounting
- Un willingness to pay for electricity
- High corruption

This study is concerned with how do the above-mentioned problems exist within Bhujung MHP. Similarly this research has been mainly focused on how this Bhujung MHP has been helping in rural development within the project area after its completion.

1.3 Objectives of the study:

The general objective of the study is to find the role of micro hydropower development in rural development. However, the specific objectives of the study are:

(a) To find out the use of electricity for different purposes;
(b) To examine the educational status of the study area;
(c) To asses the improvement in the health of the local people;
(d) To examine the on going economic activities in the study area;
(e) To find workload of the women in the study area.

1.4 Significance of the Study:

There are few studies about micro hydro and rural development in Nepal. These studies mention about micro hydro and rural development separately. This study will help aware the local people about the use of electricity and benefit from it. At the same time this study will help them motivate to use the available water resources for power generation from micro hydro plants and to use the same for different purposes as per their requirements. And this study will also help to those people who are interested to know the significance of micro hydro in rural areas. This research will help the planners and policy makers to know the actual effects of micro hydro project in rural areas and help them plan for other micro hydro projects in different locations within the country.

1.5 Limitations of the Study:

(a) This research is completely based on Bhujung Micro Hydro Project. So the variables used in this study may not fit or represent the whole country and this study may or may not be generalized;
(b) Financial and time constraints are the other limitations of the study;
(c) Political affiliation, gender biasness, insurgency and varying psychological attitude of the local people are the other factors that might have affected the responses.

1.6 Organization of the Study:

The study is organized in six chapters. The first chapter deals with introduction whereas the second chapter includes the literature review. Chapter three consists of research methodology followed by micro hydro projects in Nepal in chapter four. Similarly, the chapter five and six deal with data analysis and presentation and summary, conclusion and recommendation respectively.

Chapter Two

LITERATURE REVIEW

2.1 Conceptual Review

A society cannot rise above the subsistence economy unless there is abundance of energy. Therefore energy needs to be included in the list of basic needs of population. High GDP implies high productivity. Productivity is raised through improvement in technology and energy inputs to support the new technology. Lack of energy is often a constraint in rural development as it holds people back from achieving a better lifestyle. Many routine jobs that rural people have to do manually can be done using an external source of energy thus releasing people from drudgery and allowing them to be far more productive in their use of time. Small turbine technology has been developed in many countries that can allow both shaft power and electricity to be generated from small streams flowing down hillsides cheaply and efficiently. Shaft power can be used directly for food processing\ such as rice hulling\ the flour and the pressing of food oils from seeds (Mahat, 2004).

Micro-mini-hydro projects are located in rural areas at considerable distance from electric transmission lines and distribution network. Access from nearest road will be by foot or mule, with duration of a few hours to several days. The economic conditions in the settlements vary from very poor at subsistence level to relatively well off communities at or close to popular tourist routes or trade centers. The communities can differ considerably with regard to the degree of caste homogeneity and ethnic diversity of the population (Poudel, 2004).

Micro hydros are the projects that generate small amount of mechanical or electrical power. Generally, the projects are classified on the basis of amount of power produce into large, medium, small and micro-hydro. In, Nepal hydropower projects upto 100 KW are classified as Micro hydro projects (AEPC, 2000).

Micro hydro plants have been categorized into Micro-hydro electrification scheme, Turbine mill and Improved water mill. Further the following definitions can be adopted (AEPC, 2004).

- A micro hydro electrification scheme is an isolated hydropower system that generates upto 100 kW electrical power and serves nearby households through a local grid. This includes Pico-hydro schemes of up to 3 KW capacity sizes as well.
- A turbine mill is a hydropower plant that generates only mechanical power typically in the range of 5-20 KW and powers mainly agro processing machineries through belt.
- An improved water mill is an improved version of traditional waterwheel with vertical axis and metal runner that is primarily used for grinding and de-husking.

MHP are characterized by a relatively low power output (less than 10 KW) in mechanical form that meets the agro-processing requirement of village residents at affordable cost (Bajracharya et al, 1991).

According Hora (1994), Micro hydropower is one of the most popular energy in Nepal that is technically and economically feasible and most appropriate technology for Nepal. This technology provides access to electricity and other mechanical forms of energy for agro processing such as rice hulling, grinding and oil expelling.

2.2 Review of Related Studies

In rural areas of Nepal, energy needs at the household level are almost met through traditional sources and indigenous technologies. For instance, 88 percent of the total energy consumption in Nepal is met by biomass, of which the major share comes from firewood [CES, 2000]. The rest is met by commercial energy sources. According to Banskota and Sharma, 1999, only about 14 percent of the total population has access to electricity, and this figure drops to just 3 percent of the rural population. There are many limitations when using traditional energy resources though they are sometimes convenient for women to use. For instance, cooking with traditional stoves causes faster depletion of firewood resources, a reduction in agricultural productivity (transfer of biomass from farm to the fireplace), and increase in the drudgery of women (women's time is required for laborious tasks such as fuel collection), and it affects women and children's health with increased domestic air pollution. Women's drudgery further increases with scarcity of firewood, since they have to walk very long distances to collect the firewood to meet their basic energy demands. Similarly, women spend maximum time and energy in processing grain with traditional technologies. However, such indigenous technologies are still used as an integral part of rural livelihoods. Women have a major responsibility in managing household energy systems. Thus, energy needs are directly related to women's workload and their time. For instance, women in rural mountain areas often still spend five to six hours collecting firewood and two to four hours processing grain with indigenous technologies (Singh, 2004).

The women's metabolic energy is often made invisible and almost forgotten by the rural energy planners [Cecelski, 1995]. For instance, water mills for grinding grain fall under the energy sector, whereas women doing the same task with other indigenous technologies do not. Ignoring human energy disadvantages women in particular, since women provide significant amounts of labor and time in managing household energy systems.

Similarly, as per the report of East Consult (1994), there are alternative (renewable) energy technologies that offer significant potential in terms of reducing women's drudgery and improving health conditions, allowing women to have enough time to be involved in income-generating, social and community development activities as well as providing local employment opportunities to rural women. For example, biogas, micro-hydro, and solar photovoltaic have been found to have a positive effect on women's daily workload, their living conditions, and economic empowerment.

WECS (1994), in its final report on the improvement of economic viability of MHP plants, has analyzed the different issues related to the development of MHPs.This study was mainly based on the case studies of Barpak, Ghandruk, Angaha and Bhadure MHP

plants. This report also indicates that MHP plants are the only major sources of energy capable of breaking the socio-economic stagnation of the remote rural areas of Nepal.
The environmental and the socio-economic impacts of the mini and micro hydro power plants have been studied and analyzed in the report of ICIMOD (1991). This study has been mainly focused on the development of hydropower and its policies in the country. Similarly, this paper has also concluded that the privately owned and installed MHP plants are more profitable than that of the publicly owned.

Jantzen and Koirala (1989) evaluated the impacts of micro hydropower system in the hills of Nepal and future development prospects. This study has been based on the informations collected from 15 different sites and made the recommendations and suggestions on the socio-economic impacts of the turbine mills on villagers and the local economy. According to this study, an almost 90% micro turbine of capacity 5 KW to 100KW were being used for agro-processing and electricity generation and has positive impacts on households and community level.

According to the study conducted by East Consult (1990), the micro hydro turbines are useful only for the compact settlements and not for the spread villages. This study is also related to the performance of both owner and the consumer. The problems that are associated with the operation of micro hydro in the rural areas as highlighted by this study are; electricity itself is not productive, lack of knowledge in operation and maintenance, problem for the collection of tariff and high operation and maintenance cost as compared to the income of the consumers.

Berend (1991) analyses the socio-economic and environmental impacts of micro hydropower in remote rural areas of Nepal. For this study they had taken a study of twenty-two sites of Jumla. This study has concluded that the micro hydro cannot transform the remote Nepalese areas into the rapidly developing societies and change the undeveloped communities. This study has also emphasized that the income of the rural people must be increased before the installation of any micro hydro in the corresponding areas and these plant are more suitable for agro-processing.

Hora (1994) has limited his study to the power plants upto 100 KW that are classified micro hydro in Nepal. This study has been mainly focused on economic issues of micro hydro like financing, management and structure of tariff along with the role of micro hydro on rural electrification. This study also shows that micro hydro is continuous source of energy, non-polluting, efficient, widely available and distributed through out the country. So this MHP technology is very simple that is suitable to supply energy to the isolated rural areas of the hills and mountains of the country. This study has also highlighted the importance of data and information regarding different aspects of micro hydropower development.

In today's developing world, interventions have been targeted at economic growth while overexploiting local natural resources, which offers little or no benefit to local communities. This has a negative implication for addressing poverty and sustainable development. For instance, construction of large dams usually has many negative impacts on the local community as they destroy their settlements, the local vegetation, biosystem, and the whole socio-economic setting as is the case with the Theun Hinboun project in Laos and on-going dam projects along the upper branches of the Mekong in China (Kazmin and Penh, 2002).

No doubt, energy is a key input for sustainable development. However, energy is not an end in itself, but rather a means to achieve the goal of sustainable human development [Kartha and Larson, 2000]. Hence, growth cannot be ensured with the mere availability of energy, but rather with the quality of energy services that emphasize efficiency, equitable social distribution, and minimum environmental impact (Mak and Shearer, 1996).

Energy use has multiple social dimensions, such as poverty alleviation, population growth, urbanization, and lack of opportunities for women (Johansson and Goldemberg, 2002). At present, energy use patterns are skewed towards conventional energy sources, which not only hamper economic growth and conservation of the environment, but also aggravate social and gender inequities (Shailaja, 2000). For instance, depletion of biomass resources at a rapid rate has more negative impact on women than on men in terms of increasing their drudgery in household energy management. The current level of energy consumption and production threatens the ecosystem, economic growth, and human survival (Johansson and Goldemberg, 2002).

The conventional strategies are large-scale, supply-oriented, and fossil-fuel-intensive. They do not address the needs of the poor (Kartha and Larson, 2000). Energy services the past focused on technical and economic issues and more recently environmental aspects of energy, with social concerns receiving little attention. In order to establish a balance, is essential to consider all economic, social and environmental factors in parallel and use a ‘‘people-centered approach looking at how energy affects people’s lives’’ (Keeble, 2002). The alternative energy strategies that address multiple social issues are required to develop a sustainable rural energy system and help reduce poverty. Hence, the Alternative Energy Technologies having the potential of maximum social and economic benefits and minimum environmental impact become important means of achieving sustainable livelihoods.

Since women are primary users and managers of energy resources, the adoption of alternative technologies largely depends on the interests and the needs of women, even though men are the main decision-makers at the household and community level. Hence, while planning any interventions on rural energy, women’s needs and priorities should also be taken into account. Unless women’s energy is accounted for and credited, alternative energy initiatives are likely to remain unsuccessful, as the human element, a critical factor of sustainable development, has been neglected. Ideally, women’s active participation in alternative energy initiatives including planning and energy- based socio-economic activities should help women both to become empowered and to sustain the hole rural energy system (Mahat, 2004).

Micro-hydro power has proved very successful as a tool to help rural people develop their economic position and improve their life style. It provides extra energy in a rural area to reduce the drudgery of food processing and it can offer a means of generating electric power in areas well away from the grid. The success of any programme using such a technology depends on a wide range of factors that must all be considered and covered effectively. These include the manufacture and installation of the technology itself but also making sure the technology is used for purposes for which people have a felt need and which are economically viable. The financing of the installation of the technology through loans and subsidies is another area that needs careful planning over a term of several years (Fulford et al, 2000).

Most of the community people are taking MH as a substitute of kerosene lamp, so they are worried only for the bill they have to pay; they don't care about the services they would get from the micro hydro. The income generating activities can be effectively implemented if the people are encouraged for consuming more electricity. The products from micro hydro end-uses simply couldn't compete in free commercial market because of high production cost and lower quality. End uses are more place specific and mainly depended on economic situation, raw material potentiality and accessibility to the market. Therefore, the possibility of end use promotion should be taken as one of the selection criteria during the feasibility study of each MH. Similarly, most of the beneficiaries consider the micro hydro electricity, as a short term solution of electrification until the grid electricity is arrived to their village, are not so much serious about the depreciation cost. Therefore, the rural electrification policy should be revised. The micro hydro potential area should be identified first, and an option should be explored to the local community through the local bodies i.e. DDC/VDC. Those who want to relay on MH for long term, priority should be given for them and the extension of grid should be focus on non-micro hydro area. This in one hand optimizes the national resources and equally increases the dedication of the community people towards the long term running of MH schemes. (Paudel, Undated).

According to the conclusion drawn by REDP (2005), community micro hydro system development based on community mobilization is feasible for inclusive rural development and poverty reduction encompassing all households irrespective of class, cast, creed sex and economic status. In the context of Nepal, it is the best-proven modality to access electricity to the poor, which is neglected or marginalized by the grid extension and also by the private owned micro hydro systems development.

- Holistic development approach is essential for the sustainable operation and management of the micro hydro systems. The energy alone is not sustainable.
- In case of Nepal, the micro hydro systems are cheaper solution to electrify remote settlements, as extending the national grid to small villages is not financially viable due to the high cost of electricity transmission and distribution, low load factor and poor economic conditions.
- Rural people are capable of planning, implementation and management of micro hydro systems with the proper guidance and supervision.
- People-led micro hydro systems development can work and sustain in the difficult security situations. Women are more active in micro hydro systems development than men as electricity and additional income make their lives easier and fulfilling. Positive discrimination is necessary to empower women and vulnerable communities that include indigenous people, marginalized community and ethnic groups.
- The availability of power spurs the promotion of income generating activities and micro enterprises as rural people are always in search of opportunities and options for employment ands income generation to fulfill their basic needs and other needs.

Thus from the above review we come to know that though Nepal possesses huge potentiality for hydropower generation and the progress of MHP installation is not at satisfactory level. Similarly, there are many organizations that work for the development of MHP but it seems they lack coordination with each other. There are a few studies about MHP that are not covering all aspects of MHP development and it needs more studies about MHP in Nepal. So, this study is an attempt to fulfill that lacking.

Chapter Three

RESEARCH METHODOLOGY

3.1 Selection of Study Area

Bhujung Micro Hydro Project was selected for the research.The study was limited to Bhujung VDC that is located in Lamjung District. It is approximately 1700m elevations and 18 Km northwest of Besishahar, the District headquarters of Lamjung. It takes about 6-8 hrs to walk to Bhujung from the nearest road at Besishahar. The village of Bhujung is a mainly Gurung community with 362 houses clustered together. The main source of income of the inhabitants of this village is agriculture, primarily paddy and wheat on irrigable land and corn and millet on the hillside. Most households also have cows, buffaloes, goats and pigs. Some members are enlisted in the Indian Army and come home only during festivals and holidays.

It is always said that micro hydro projects are the important factors for the rural development in national context. It is often also heard that Bhujung Micro Hydro Project is also said to be running successfully and helping rural people for up lifting their living standards. I am being from the same district and very much interested to know the effects of this micro hydro project in rural development in the project area. And more over, till now no body has done such type research work in Bhujung VDC about this topic. So, this micro hydro project was selected for research work.

3.2 Research Design

This is descriptive cum explanatory research design. This shows the economical, educational and health status of the people and the workload of women of this VDC after the implementation of Bhujung MHP and analyses the role-played by the MHP in rural development of the area.

3.3 Universe, Sample Size and Selection Procedure

Bhujung VDC has a total population of 2085 according to census 2058 BS. Bhujung MHP supplies electricity to all the wards of Bhujung VDC. Thus universe of the study consists of all the users of Bhujung MHP. Stratified random sampling has been used to choose the samples. The sample size of the population was 50 different households that are using the electricity from Bhujung MHP. For sampling purpose it was noticed that there must be representatives from all wards randomly.

3.4 Nature and Sources of Data

Both primary and secondary data were used to provide full information about the study. Primary data were collected mainly through structured questionnaire, field observation and discussions. The secondary data were collected from the available literatures such as records of study reports, records and publications of ACAP, ICIMOD, CBS, and other micro hydro related published and unpublished books and articles. Similarly, the records of VDC and DDC were also used. Dissertations published and unpublished researches and other materials from library were also found helpful for this research.

3.5 Tools and Techniques of Data Collection

Different tools and techniques that have been used for data collection for this research work are Focus Group Discussion, Set of Organized Questionnaires, Personnel Interviews and Field visit by the researcher.

3.6 Techniques of Data Analysis:

Both the qualitative and the quantitative data have been orderly processed and analyzed with the help of simple statistical methods such as addition, percentage and presenting them in tables and charts.

Chapter Four

MICRO HYDRO PROJECTS IN NEPAL

4.1 Definitions

Hydropower schemes in the range of 3 KW to 100 KW units are known as micro hydro. Micro hydro is an indigenous technology and is one of the few energy options, which can viably reach rural communities of the country. It is a reliable and clean source of energy.

Table 4.1 Classifications of Hydro Systems.

Size	Application	Power	Classification
Very Small	Family	Less than 3 KW	Pico Hydro
Small	Village Scale	5 to 100 KW	Micro Hydro
Medium	Grid or Mini Grid	100 KW 5 MW	Mini Hydro
Full-Sized	Connected to Grid	Greater than 5 MW	Full-Sized

Source: Journal of International Development, 2000.

Waterpower can be converted into mechanical energy by using water turbines and into electrical energy by using electricity-generating equipment. The quality and the quantity of water flowing depend on its sources.

The power available from micro hydro plants can be used for the following purposes

- Rice Hullers
- Corn grinders
- Oil Expellers and
- Generators

It can be integrated with irrigation and water supply projects to maximize the benefits. Besides being in the local area, local people can take maximum benefit from MH plants.

4.2 Technical Aspects

Some of the technical aspects of micro hydro power plant can be discussed as follows.

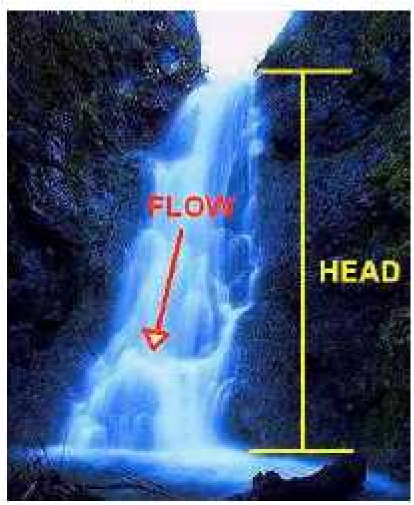
4.2.1 Head and Flow

Hydraulic power can be captured wherever a flow of water falls from a higher level to a lower level. This may occur where a stream runs down a hillside, or a river passes over a waterfall or man-made weir, or where a reservoir discharges water back into the main river. The vertical fall of the water, known as the “head”, is essential for hydropower generation; fast-flowing water on its own does not contain sufficient energy for useful power production except on a very large scale, such as offshore marine currents. Hence two quantities are required: a Flow Rate of water **Q**, and a Head **H**.

The Gross Head (H) is the maximum available vertical-fall in the water, from the upstream level to the downstream level. The actual head seen by a turbine will be slightly less than the gross head due to losses incurred when transferring the water into and away from the machine. This reduced head is known as the Net Head. Sites where the gross head is less than 10 m would normally be classed as “low head”. From 10-50 m would typically be called “medium head”. Above 50 m would be classed as “high head”.

The Flow Rate (Q) in the river is the volume of water passing per second, measured in m3/sec. For small schemes, the flow rate may also be expressed in litres/second where 1000 liters/sec is equal to 1 m3/sec.

Figure 4.1 The Gross Head



4.2.2 Power and Energy

Energy is the work done in a given time, measured in Joules. Electricity is a form of energy, but is generally expressed in its own units of kilowatt-hours (KWH) where 1 KWH = 3600 Joules and is the electricity supplied by 1 KW working for 1 hour. Power is the energy converted per second, i.e. the rate of work being done, measured in watts (where 1 watt = 1 Joule/sec. and 1 Kilowatt = 1000 watts). Hydro-turbines convert water pressure into mechanical shaft power, which can be used to drive an electricity generator, or other machinery. The power available is proportional to the product of head and flow rate. The general formula for any hydro system's power output is:

$$P = h\, r\, g\, Q\, H$$

Where,

P is the mechanical power produced at the turbine shaft (Watts),

h is the hydraulic efficiency of the turbine, **r** is the density of water (1000 kg/m3),

g is the acceleration due to gravity (9.81 m/s2),

Q is the volume flow rate passing through the turbine (m3/s),

H is the effective pressure head of water across the turbine (m).

The best turbines can have hydraulic efficiencies in the range 80 to over 90 percent (higher than all other prime movers), although this will reduce with size. Micro-hydro systems (<100KW) tend to be 60 to 80 percent efficient. If we take 70 percent as a typical water-to-wire efficiency for the whole system, then the above equation simplifies to:

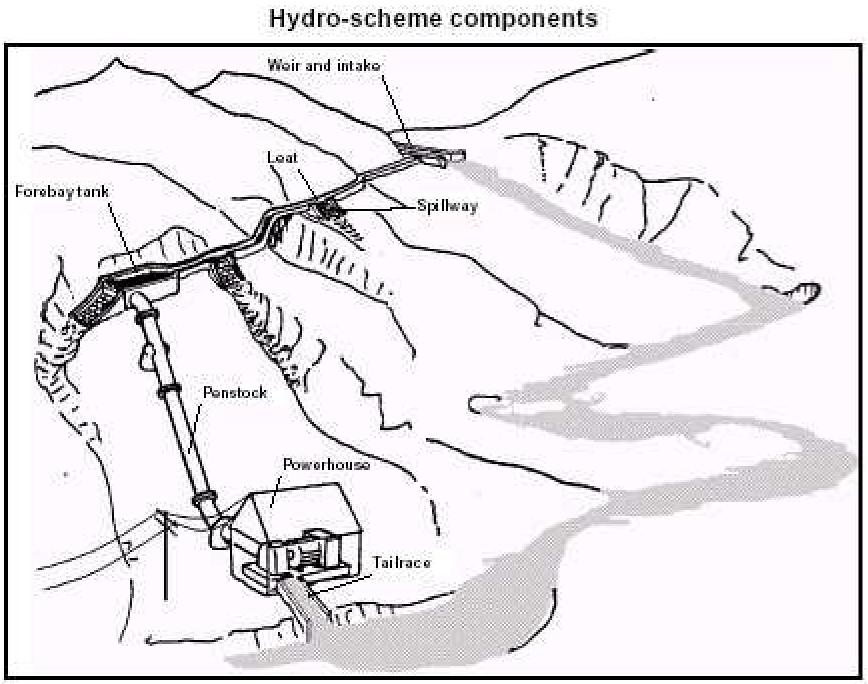
$$P\ (KW) = 7 * Q\ (m^3/s) * H\ (m)$$

4.3 Main elements of the scheme

- The main figure illustrates a typical micro hydro scheme on a medium or high head. The scheme can be summarized as follows:
- Water is taken from the river by diverting it through an intake at a weir.
- In medium or high-head installations water may first be carried horizontally to the forebay tank by a small canal.
- Before descending to the turbine, the water passes through a settling tank or 'forebay' in which the water is slowed down sufficiently for suspended particles to settle out.
- The forebay is usually protected by a rack of metal bars (a trash rack) that filters out water-borne debris.
- A pressure pipe, or 'penstock', conveys the water from the forebay to the turbine, which is enclosed in the powerhouse together with the generator and control equipment.

- After leaving the turbine, the water discharges down a 'tailrace' canal back into the river.

Figure 4.2 Main elements of a Micro Hydro Scheme



4.4 Preliminary Power and Energy calculation

4.4.1 Design Flow

It is unlikely that schemes using significantly more than the mean river flow (Qmean) will be either environmentally acceptable or economically attractive. Therefore the turbine design flow for a run-of river scheme (a scheme operating with no appreciable water storage) will not normally be greater than Qmean. The exception would be a scheme specifically designed to capture very high winter flows, which is very rare in mini-hydro applications. The greater the chosen value of the design flow, the smaller proportion of the year that the system will be operating on full power, i.e. it will have a lower 'Capacity factor'.

4.4.2 Capacity Factor

The 'Capacity factor' is expressed as follows:

Capacity factor (%) = (Energy generated per year (KWH/year)/(Installed capacity (KW) x 8760 hours/year)

An estimate of how Capacity factor varies with design flow is given as follows:

Table 4.2 Capacity Factors

Design Flow Qo	Capacity Factor
Q mean	40 %
0.75 Q mean	50 %
0.50 Q mean	60 %
0.33 Q mean	70 %

Source: British Hydropower Association, 2005.

4.4.3 Peak Power

The peak power **P** can be estimated from the design flow **Q**o and head **H** as follows:

P (KW) = 7 ***Q**o(m3/s) * **H**(m)

4.4.4 Energy Output

The annual energy output is then estimated using the Capacity Factor (CF) as follows:

Energy (kWh/year) = **P** (KW) * **CF** * 8760

There is clearly a balance to be struck between choosing a larger, more expensive turbine which takes a high flow but operates at a low Capacity factor, and selecting a smaller turbine which will generate less energy over the year, but will be working flat out for more of the time i.e. a higher Capacity factor. The Capacity factor for most micro-hydro schemes would normally fall within the range 50% to 70% in order to give a satisfactory return on the investment. Most turbines can operate over a range of flows (typically down to 20-40% of their rated flow) in order to increase their energy capture and sustain a reduced output during the drier months.

4.5 Micro Hydro Project Development in Nepal

Micro-hydro electrification started in the 1970s in Nepal. It is an indigenously developed technology . Balaju Yantra Shala (BYS) in 1962 installed the first micro-hydro project, Godawari Fish Farm Company, with a propeller turbine to drive a 5 KWE generator. Various organizations have been and established and working as key players in this sector. The development trend of micro hydro has been presented in the table 4.3, which represents the yearly installation trend from1962-mid July 2004. The installation of electrification schemes has been sharply rising after 1997. This shows the significant role of organizations, such as REDP/UNDP and AEPC in promoting the Micro Hydro sector. In the early 1990's concentration is more on mechanical milling scheme, whereas in after 1995/96 the concentration had shifted to electrification schemes.

Table4.3 Growth Trend of Micro-hydro Electrification Schemes

Year of Installation	Classification of Schemes				Total	
	Pico-hydro upto 3 KW		Micro-hydro (3-100KW)			
	No.	KW	No.	KW	No.	KW
2004	31	64.9	22	251.5	53	316.4
2003	80	184.32	53	749.5	133	933.82
2002	61	140.5	34	364.5	95	505
2001	36	81.2	50	891	86	972.2
2000	112	213.45	40	719.5	152	932.95
1999	123	226.4	25	386.5	148	612.9
1998	97	185	28	430.5	125	615.5
1997	84	143.4	16	262.7	100	406.1
1996	130	203.3	14	174.2	144	377.5
1995	115	170.9	13	145.3	128	316.2
1994	79	100.3	5	125.7	84	226
1993	-	-	3	26.5	3	26.5
1992	13	12	6	106.5	19	118.5
1991	46	43	7	125.1	53	168.1
1990	-	-	11	97.8	11	97.8
1989	-	-	17	183	17	183
1988	-	-	11	109.8	11	109.8
1987	-	-	17	190.5	17	190.5
1986	-	-	20	203.8	20	203.8
1985	-	-	16	168.8	16	168.8
1962-1984	-	-	52	424.65	52	424.65
Year not known	-	-	7	92.3	7	92.3
					Total	7998.32

Source: AEPC, 2004.

Similarly, the growth trend of turbine mills is given in table 4.4.

Table 4.4 Growth Trends of Turbine Mills

Year of Installation	No.	KW
2004	1	6.5
2003	7	52.5
2002	-	-
2001	1	10
2000	-	-
1999	2	12.8
1998	2	14.3
1997	5	35.1
1996	9	80.9
1995	12	141.2
1994	21	237
1993	13	145.65
1992	25	260.5
1991	42	415.2
1990	32	259.9
1989	37	287.7
1988	51	429.7
1987	75	709.95
1986	71	570.6
1985	88	722.3
1963-1984	273	2306.05
Year not known	41	436
Total		7133.85

Source: AEPC, 2004.

Table 4.5 Growth Trend of Improved Water Mills

Year of Installation	No.	KW
2004	380	509.93
2003	65	NA
2002	58	NA
2001	107	NA
2000	91	NA
1999	124	NA
1998	94	95.79
1997	18	21.00
1996	40	48.90
1995	44	45.58
March 1993-June 1995	137	NA
March 1991-Feb 1993	54	NA
1984-1988	80	NA
Total		721.2

Source: AEPC, 2004.

4.6 Government and Other Institutions related to Micro Hydro Projects

Although NEA has withdrawn from providing support to micro-and mini-hydro development, there are still a number of important institutions that support initiatives in the sector:

Government Agencies:

- Ministry of Water Resources (MOWR)
- Ministry of Finance (MOF)
- Ministry of Local Development (MOLD)
- Department of Electricity Development (DOED)

Public institutions:

- Water and Energy Commission Secretariat (WECS*)*, under the Ministry of Water Resources, has provided an inventory of approximately 200 potential sites for MH, meant as assistance to developers. The objective is to identify the 10-15 most viable micro-hydro power sites in each of the 63 districts having potential.
- The Alternative Energy Promotion Centre (AEPC), was formed late 1997 as an institution to promote development and monitor activities within the alternative energy sector, including Micro Hydropower.
- The Remote Area Development Committee (RADC*)*, has been given the task of establishing MH plants at selected sites in certain districts at or near the border of Tibet, designated Very Remote Areas, under the "Integrated Rural Community Development through Village Electrification Programme".

NGOs and NGOs

- United Mission of Nepal (UMN*)*, has promoted the build-up of manufacturing capabilities in micro- and mini hydro-turbines by founding local manufacturing firms and by providing technical assistance to users and manufacturers through the company Development Consultant Services (DCS), founded by UMN.
- International Centre for Integrated Mountain Development (ICIMOD), and Intermediate Technology Development Group (ITDG*)*, (active in Nepal since 1979) provide conceptual and policy-making contributions.

International Donors

- Swiss bilateral aid - through Swiss Association for Technical Assistance (SATA),

- Swiss Development Corporation (SDC) and the Swiss Foundation for Technical Cooperation (Swiss contact) - has been involved in developing village-based isolated grid schemes.
- German bilateral through GTZ (Gesellschaft fur Technische Zusammenarbeit) and German Development Service (DED) has identified options for private financed mini-hydro power projects for production to the national grid. DED supports the RADC programme.
- Danish bilateral aid, Danida has included support to micro-hydro development as one of five components in its 1999-2003 Nepal Energy Sector Assistance Programme.
- UNDP is involved in mini- and micro hydro through the Rural Energy Development Programme (REDP). It encourages the individual District Development Committees (DDCs) to establish a district level authoritative office for promoting decentralized bottom-up rural energy planning and to create a District Energy Fund.
- At the village level, the REDP promotes the establishment of community organizations COs) of male and female separately. The REDP has conducted technical feasibility surveys of more than 80 micro-hydro sites in the first five districts it was active in, and found 42 sites technically feasible.

4.7 Government Policies related to Micro Hydro Project

4.7.1 Rural Energy Subsidy Policy in Nepal

Government announced a policy of subsidy to encourage private participation in rural electrification in 1985. The development of the energy sector was given special priority in the Eighth Plan. The basic objectives of the energy plan concerning micro-hydro development were to maintain regional balance in the energy sector with hydropower by maximum utilization of indigenous energy sources, and to develop alternative and decentralized energy resources available in the country. Existing policies are that no licenses are required to operate a hydropower scheme up to 1 MW capacity. The owners are given the liberty to fix the tariff rates of their schemes.

The aim of the government subsidy policy, in general, is to assist the rural development with special attention to the economically deprived sector. The prime objectives of the subsidy are to meet social justice and balanced economic growth in the nation. The capital subsidy and interest subsidy for installing various rural energy technologies, such as micro-hydro, solar, and biogas, has come up in different shapes and sizes in the past. This can be viewed as direct subsidy. Besides, there is indirect subsidy, such as the release of taxation in the import of components of renewable energy technologies, investment on software aspects of the technology, quality assurance, R& D, training and end use promotion . The government has revised the subsidy policy for the solar and micro-hydro sector in October 2000.

4.7.2 Subsidy in Micro-Hydro Sector

The capital subsidy was introduced in the micro-hydro sector in 1985. The subsidy was channeled through Agricultural Development Bank/Nepal before the implementation of a new subsidy policy in October, 2000. As per the revised subsidy policy, a subsidy amount of Nepalese Rupees (NRs.) 55,000 per KW is provided for new micro-hydropower projects upto 3 KW capacities. Above this capacity (3 to 100 KW) NRs.70,000.00 per KW is provided to the generated output. An additional transportation subsidy of about NRs. 8,750.00 per KW to NRs. 21,000 per KW is provided depending upon the remoteness of the site.

At the first time government introduced subsidy policy for Micro hydro in 1980s and the subsidy policy has been reviewed couples of times. The present subsidy policy is presented in table 4.6.

Table 4.6 Subsidy Policies for Micro Hydro in Nepal

SN	Description	Subsidy amount (Nepalese Rupees)/KW
1	Peltric set (micro hydro less than 3 KW generating capacity)	55,000.00
2	Micro hydro (3 KW to 100 KW capacity)	70,000.00
3.	Improved electricity generating water mills supplying electricity to households	27,000.00
4	Transportation cost for projects located 3 to 5 days walking distance from road head	8,750.00
5	Transportation cost for projects located more than 5 days walking distance from road head	21,000.00
6	Rehabilitation of old micro hydro plants	50% of proposed cost or Rs.35000.00 whichever is less

(Source: AEPC, 2000)

4.8 Major Obstacles in Micro Hydro Projects Development

The commonly identified major barriers and constraints for access of electricity to the rural population are the affordability, price of the technology, awareness and lack of appropriate finance and credit facility. Certain limitations within the government policy, human resource constraints at local level have been identified as the factors supplementing the barriers for sustainable access of better energy services to the rural population. The present security situation has also delayed the pace of technology dissemination. Furthermore, the use of the electricity has been limited to lighting and there appears to be a lack of substantial productive end uses, which may create less possibility for sustainability of the technology. Energy consumption in the rural households is moderately less as compared to the wealthier households in urban areas. The rural houses in a community are much scattered resulting into high per unit capital cost for providing access to better energy services.

Chapter Five

DATA ANALYSIS AND PRESENTATION

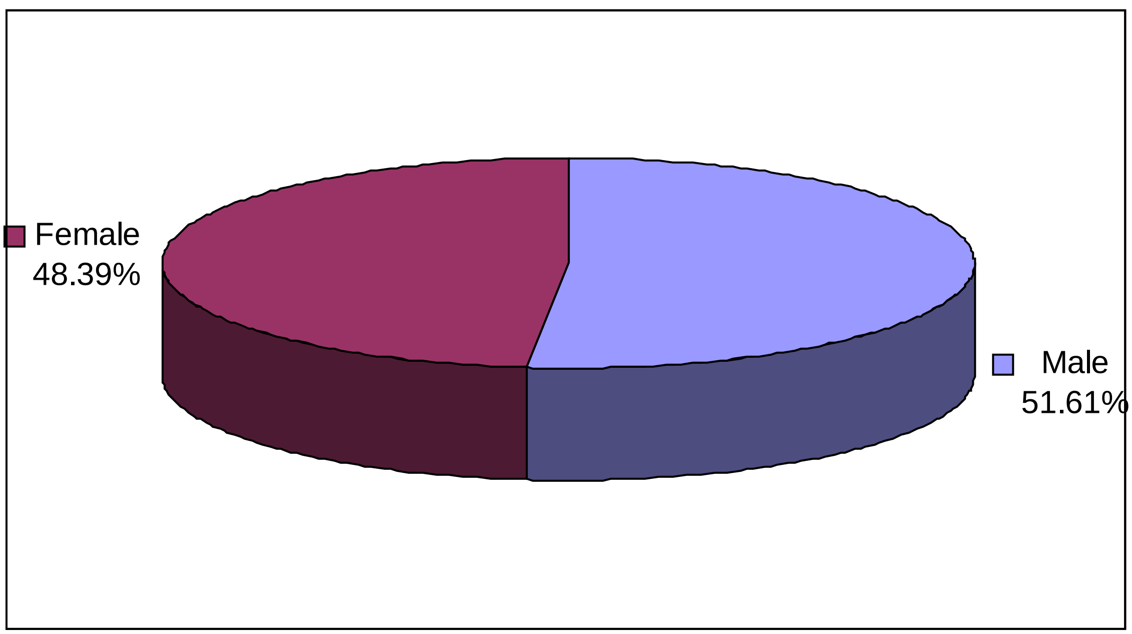
5.1 Socio Economic Condition of the Village

Socio-economic condition of any village represents its development and status. Religion, education, employment, health and sanitation are the different indicators of social and economic development that show the living standard of the people of that area and the nation as a whole.

5.1.1.Population

According to the population census 2058 total population of Bhujung VDC is 2085 with 362 households. Among the total population male constitutes 51.61 percentage and female constitutes the remaining.

Figure 5.1 Population of Bhujung VDC



Source: District Profile, 2006

5.1.2.Caste and Ethnicity

Different caste /ethnic groups are living in this VDC in close harmony with each other. They are mainly Gurung, Kami, Damai, and Sarki. Gurung is the major dominant caste group among all the ethnic groups whereas kami remains in the second position.

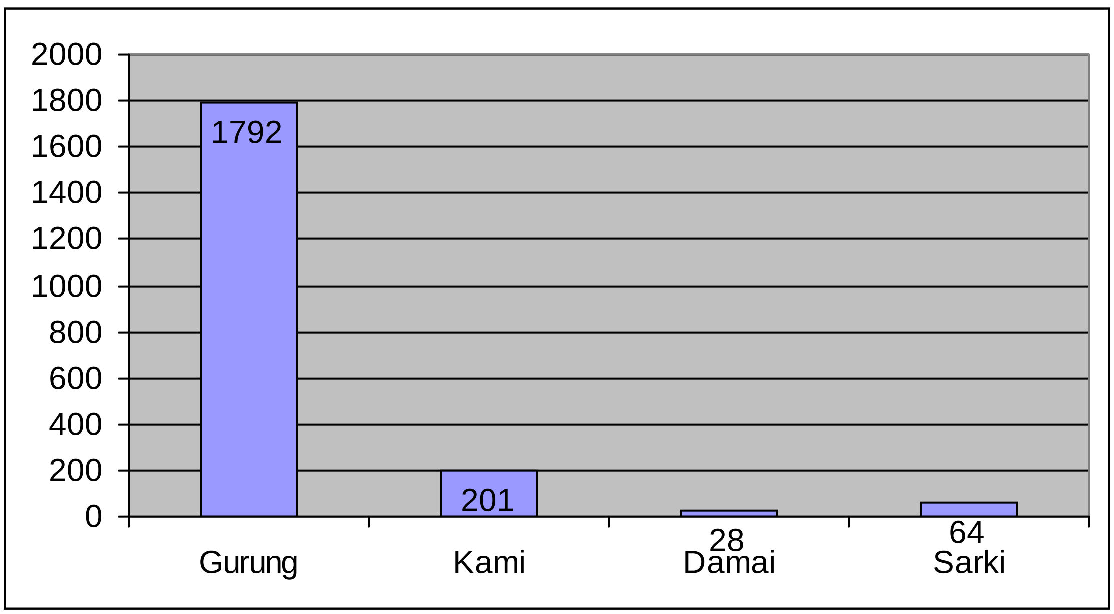
Table 5.1 Composition of Castes / Ethnicity

Caste/Ethnic Group	Number	Percentage
Gurung	1792	86
Kami	201	9
Damai	28	1.5
Sarki	64	3.5
Total	2085	100

Source: District Profile, 2006.

The distribution of population by caste/ethnic group is as given in table 5.1.

Figure 5.2 Composition of Castes/Ethnicity



Source: District Profile, 2006

5.1.3.Education

Education is the backbone of development and plays a vital role in the nation building and upliftment of the standard of living of the people. Without education one cannot expect the development of country. The educational status of different age groups of Bujung VDC is as given below in table 5.2.

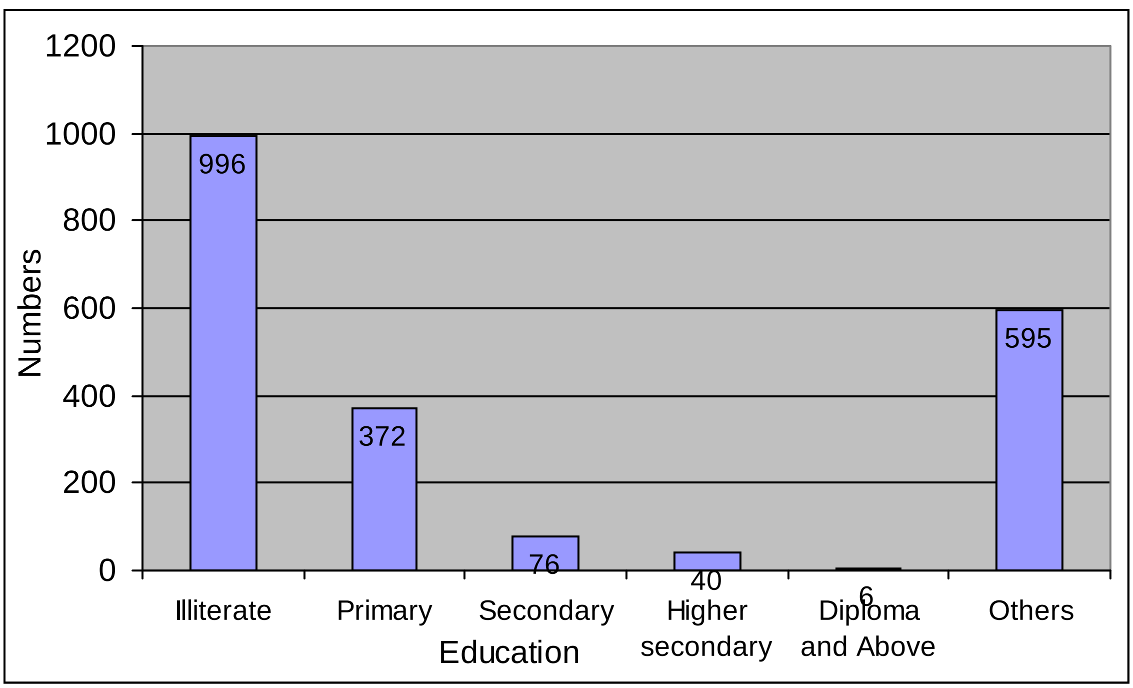
Table 5. 2 Educational Status of Bhujung

Educational Status	Numbers	Percentage
Illiterate	996	48
Primary	372	18
Secondary	76	3.6
Higher Secondary	40	2
Diploma and Above	6	Less than 0.3
Others	595	28.53

Source: District Profile, 2006.

From table 5.2 it is seen that maximum percentage (48 %)of the population is illiterate while less than 0.3 percentage has qualification of diploma and above. Similarly, eighteen percent of the total population has primary education whereas only two percentage has completed higher secondary level.

Figure 5.3 Educational Status



Source: District Profile, 2006.

5.2.Introduction of Bhujung Micro Hydro Project

Bhujung Micro Hydro Project lies in Bhujung VDC.This MHP produces 80 KW of power which has been distributed in all ward of the Bhujung and ward number four and five of Kam Gaon.In total this Bhujung MHP supplies electricity to 450 households of both the VDCs. The total cost of construction was Nrs 1,20,00,000.00 and was completed and commissioned since 2055 BS.It was built with the assistance of an NGO called KADURI (Ex-Britsh Welfare Organization), Bhujung VDC and ACAP.

The powerhouse is located on a small terrace in the right bank of Midim Khola.This MHP uses the water of Midim Khola for power production. The transmission length form powerhouse to Bhujung and Kam Gaon are 1.0 Km and 2.0 Km respectively. The gross head of this MHP is 40.00 m and the efficiency is of 60% and a design flow of 340 l/s. The cost of construction of this MHP is about NRs 1,50,000.00 per KW.

According to the consumers the plant is operated 24 hours a day. For the smooth operation of this plant there are three employees; one manager and two operators. This plant is overally managed by the MHP Management Committee, which comprises of nine members. The consumers of this MHP pay a monthly charge of 65 Paisa per watt for household purpose and 75 Paisa for other purposes.

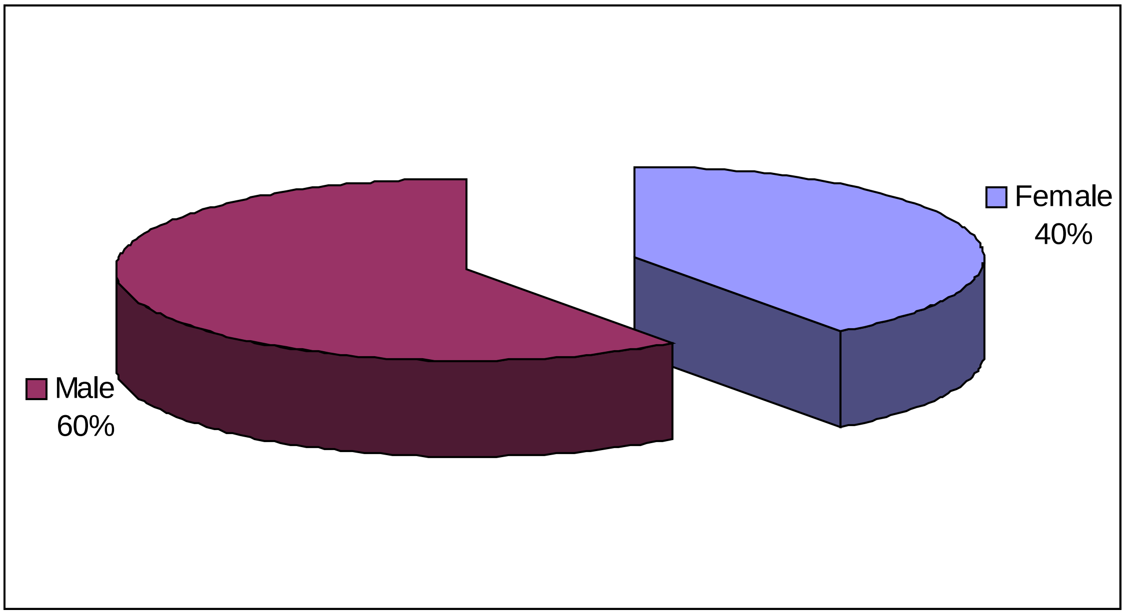
5.3 Analysis of Questionnaire Survey

Different questions were asked to know the use of electricity for different purpose. Similarly the questionnaire survey and focus group discussions were held to examine the on going economic activities and the educational status of people living in the study area in the study area, to assess the improvement in the health of the people and the workload of women of the study area. The details of questionnaire have been presented in **Annex.** Some important features of the survey result have been analyzed and presented below.

5.3.1.Composition of Respondents According to Gender

Altogether there were fifty respondents from different households from different wards. There were minimum five representatives from each ward. They included both men and women of different professions. In total thirty men and twenty women were interviewed during questionnaire survey.

Fig 5.4 Composition of Respondents According to Gender

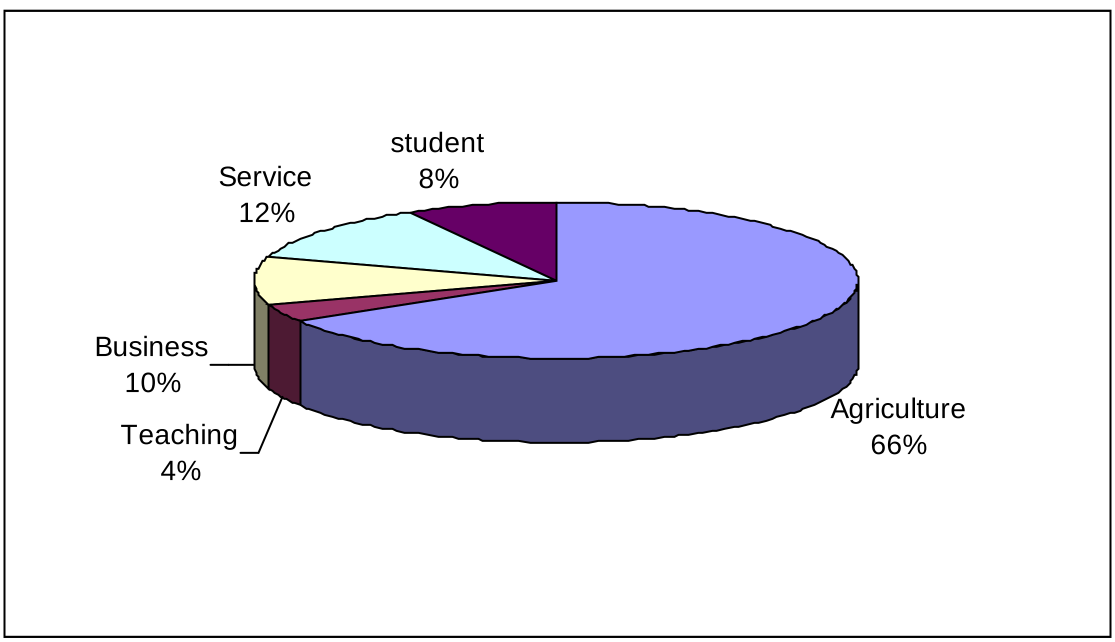


Source: Field Survey, 2006.

5.3.2.Composition of the Respondents by Profession

The respondents were a conglomerate of persons of different professions. They included

Fig 5.5 Composition of Respondents by Profession



farmers, teachers, businessmen and service holders. The detail of their composition is given in Fig 5.5.

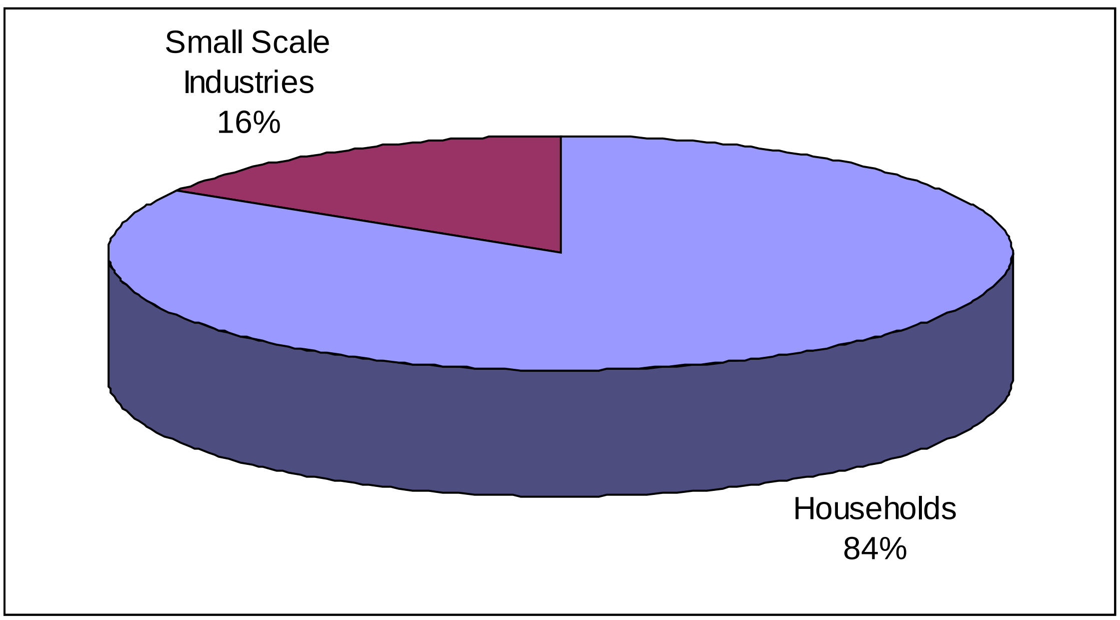
5.3.3 Use of Electricity for Different Purposes:

There is a belief that electricity can bring the desired socio economic changes in rural areas. This is true in most of the cases, as rural electrification has brought some positive changes in the rural area. In our study the following result has been witnessed.

5.3.3.1 Use of electricity by purpose

From the survey it is found that 84 percent household use electricity for household works whereas the remaining sixteen percent households use for small-scale industries.

Figure 5.6 Use of electricity by purpose



Source: Field Survey, 2006.

5.3.3.2 Use of electricity for household purpose

All households are connected to electricity. It is known that came to know that at present cent percent of the respondents have electricity in their home and some of them use electricity for more than one purpose. So as per the result obtained from the field survey it is known that cent percent households are using electricity for lighting purpose, ten percent for cooking purpose and the mere four percent for heating purpose also. It is true that all use it for lighting. Some use it for additional purposes like heating and cooking but they are unable to do so all the time because of the insufficient power supply. The household supply of electricity is both power and voltage limited. One household can have only minimum of 25 watt to maximum of 500 watt of power supply that is insufficient to do works other than lighting. Some ten percent as said above use electricity for cooking rice and mere four percent use for boiling water in off peak hours with the permission of the management committee. This is presented in Figure 5.7 below.

5.3.3.3 Use of electricity for agro processing

There are two agro processing mills located almost at the center of Bhujung VDC. This mill is mainly used for rice husking, grinding millet, maize and wheat, and oil expelling. This mill consumes 4 KW of power for each unit. The huller has a capacity to process 75 Kg per hour while the grinder can process 35-40 Kg per hour.As per the information given by the owner of the mill, a total of around 25,000 Kg of rice can be hulled annually whereas the grinder can process 60,000-70,000 Kg of wheat, millet and maize. The present cost of husking rice and grinder is Rs 2.50 and 2.00 per Kg. Altogether ten people have been employed in these two agro processing mills. According to the mill owners almost all the people of this VDC have taken the advantage of these mills.

5.3.3.4 Use of electricity for different economic activities

Electricity it self is not productive but it has to be used in productive end uses. So, if there is sufficient electricity supply then different types of economic activities can be started at local level also. But if the electricity supply is not sufficient economic activities cannot go ahead. In our study also there were only 16 percent respondents have got chance to start some economic activities. As per the survey except two agro processing mills there are four bakery shops, four-carpentry/furniture workshop and three TV/Radio repairing shops in the study area.

According to them they are using the electricity for their shops. The carpentry works shops saw logs for different furniture. According to the respondents and the owners they prepare different types furniture like beds, benches, table, chairs and racks. They sell these items to the local people comparatively at low prices than brought from other places. Similarly, there are three TV/Radio repairing shops. These shops sell radio brought from district headquarters, Besishahar and do the repairing and maintenance works. According to them it is because of the electricity that they had started this job instead of going outside in search of employment. Similarly the bakery shop owners also use electricity to make different kinds of breads and biscuits, which are consumed in the study area.

5.3.3.5 Use of electricity for different instruments

From the survey it was known that almost cent percent households have radio, forty percent have TV. According to them they use electricity for both radio and TV. From survey it was also known that some thirty percent households use electricity for battery charge. Before electricity there was not a single Television in the Village. All of them univocally stated that it is because of this micro hydro project they have got an exposure with different means of entertainment and information.

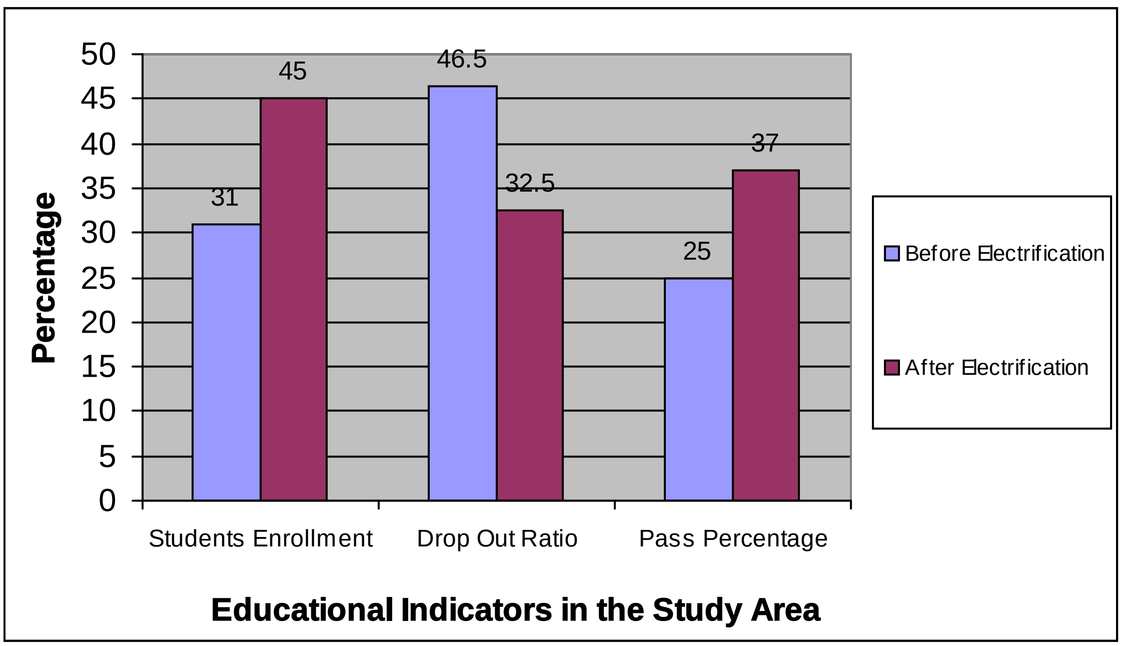
5.3.3.6 Electricity for Battery Charging

As obtained from the survey cent percent respondents have radio. So they have to spend a lot of money for purchasing battery for their radios. Now, from the survey it is known that some 30 percent respondents are using electricity for battery charging. From battery charging around fifty percent of thirty percent households can save upto Rs 200.0 per month.

5.3.3.7 Electricity for Education

It is known that education is the backbone of development. It is an important factor for the economic and social development of a country. People require skill and knowledge fort production of goods and services. Education perhaps is a single means of acquiring skills and knowledge. It is more important and quite essential for the least developed countries like Nepal. Development in education is an indication of social development. It plays a vital role in nation building and upliftment of the standard of living of the people. Here in our case also education is interlinked with electricity .As per the records obtained from the resource center Uttarkanya, Lamjung, the average student enrollment before and after electrification was 31 percent and 45percent respectively. Similarly, the drop out ratios are 41 percent and 52 percent for boys and girls respectively before electrification whereas the same ratios seemed to have changed to 28 percent and 37 percent respectively after electrification. The other indicator is the pass percentage of students before and after electrification. The average pass percentage as obtained from the Resource Center and the District Education Office, Lamjung before and after electrification is around 25 percent and 37 percent respectively. From all these data it is known that electricity has played a significant role for the improvement of education in the study area.

Figure 5.7 Educational Status Before and After Electrification

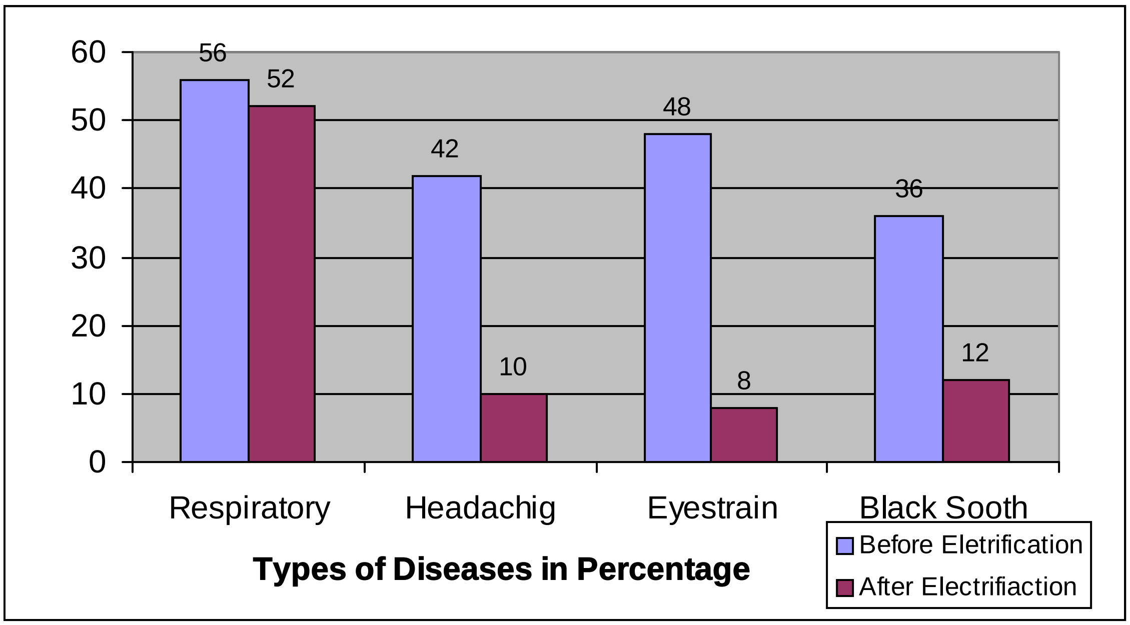


Source: Field Survey, 2006.

5.3.3.8 Electricity for Health

According to the district public health office, Lamjung, head aching, eyestrain black sooth and the respiratory diseases are the diseases that frequently occur in the rural areas and the main cause of these diseases in the village is the use of kerosene lamp for lighting and firewood for cooking. So a large amount of money is being spent for the treatment of these diseases. This study has also proved that the above-mentioned diseases are the main diseases in the study area caused by the use of kerosene and fuel wood. According to the survey some 56 percent said they were suffering from respiratory disease, 42 percent form head aching, another 48 percent from eyestrain and 36 percent from black soothing before the electrification. Now this scene seems to have changed to some extent. But as per the result of the survey people suffered from respiratory disease, head aching, eye strain black soothing were 52 percent, 10 percent, 8 percent and 12 percent respectively. So moreover it is seen that the rural electrification plays a significant role for changing the health status of the people of Bhujung VDC. This is given in the Figure 5.8 below.

Figure 5.8 Health Condition Before and After Electrification

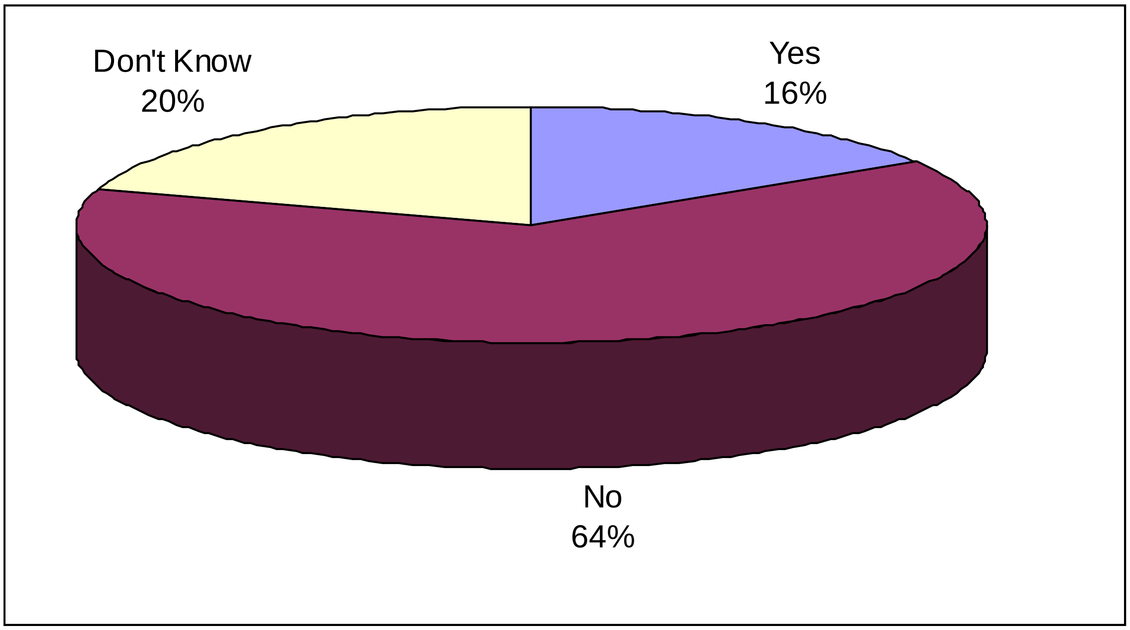


Source: Field Survey, 2006.

5.3.3.9 Electricity for employment generation

When asked whether electricity has created employment opportunities and increased the economic activities in the village after electricity, 16 percent respondent said there is increase in economic activities, 64 percent said no and 20 said they didn't know. From the field observation also it was found that this MHP has not provided direct employment to the respondents except for two MHP operators at present. But many people got involved in different activities during its construction phase. Similarly according to the respondents this MHP has helped to start different economic activities like mills operation, radio TV repair and maintenance work, bakery shop and saw mills as mentioned above.

Figure 5.9 Responses on Employment Generation

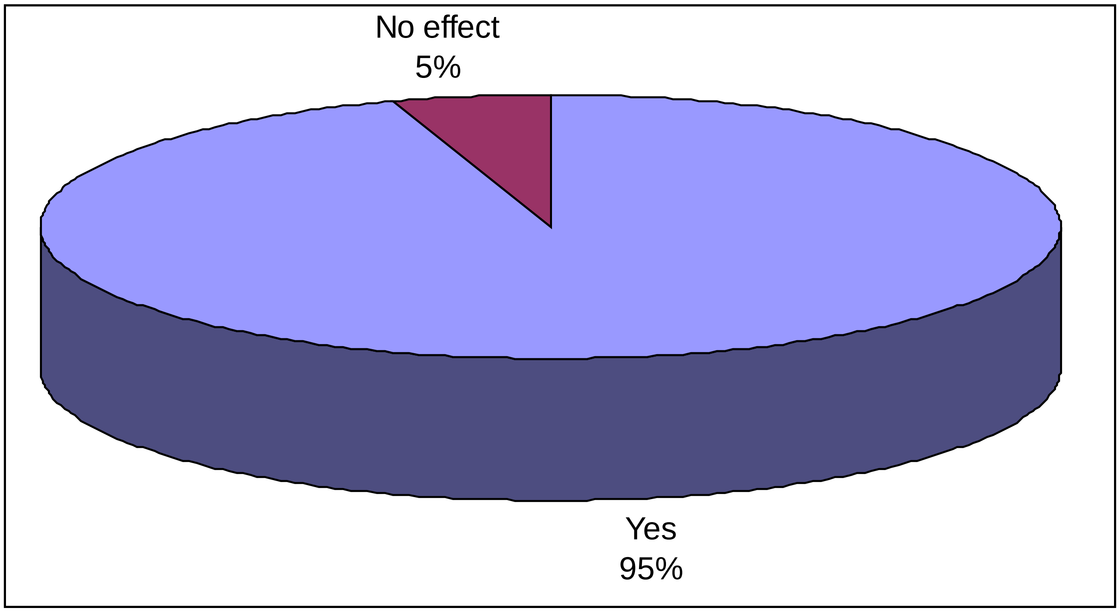


Source: Field Survey, 2006.

5.3.3.10 Workload of Women

It was difficult to directly find out the workload of the women of the study area. For this work besides regular questionnaires some 20 women mostly engaged in agriculture and animal husbandry were gathered and asked whether Bhujung MHP has helped them reduce their daily household chores. In that discussion around 80 percent respondent said that they used to use Dhiki/Janto for agro processing before the introduction of MHP that used to take lots of time. They also said that for that purpose almost daily they had to get up early in the morning (i.e. around 3.00 am). So they had to do a very hard work and used to get very little time for taking rest and other works. They did not have any time for entertainment, attend their children and for other productive works. As per their reply they had to work at least eighteen hours a day compulsorily. But now the case seems to have changed a lot. Almost 100 percent respondents said that they go to the agro processing mills for rice hulling, oil expelling and grinding millet, maize and wheat that is run by electricity .In their own words, they spend less time for different agro processing works after electrification and they have got enough time to sleep at night, some time to take rest, some time to listen to the radio and watch television in the evening. Similarly they have got enough time to take care of their children. They said that because of this reduced workload there is improvement in their health condition also. But some 5 percent said that electricity has no effect in their household chores.

Figure 5.10 Response on Reduction in Drudgery/Workload of Women



Source: Field Survey, 2006.

Chapter Six

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

This study was conducted to evaluate the role of rural electrification in rural development. The study mainly focused on the role played by the Bhujung MHP in Bhujung VDC of Lamjung district. Specific objectives were as follows:

(a) To find out the use of electricity for different purposes;

(b) To examine the educational status of the study area;

(c) To assess the improvement in the health of the local people;

(d) To examine the on going economic activities in the study area;

(e) To find workload of the women in the study area

The study was based mainly on the primary data collected from the Bhujung VDC through various tools and techniques . Fifty households from all wards were chosen for stratified random sampling. Simple arithmetic/statistical tools were used for data analysis.

Summary of the main findings of the study are as follows:

- 100 percent households are using electricity for lighting purpose, 10 percent for cooking purpose and the mere 4r percent for heating purpose as well.
- Most of the respondents want to use the electricity for cooking and heating purposes but they are unable to do so because of the insufficient power supply. The household supply of electricity is both power and voltage limited.
- One household can have only minimum of 25 watt to maximum of 500 watt of power supply that is insufficient to do works other than lighting. Some 10 percent as said above use electricity for cooking rice and mere four percent use for boiling water in off peak hours with the permission of the management committee.
- Sixteen percent respondents have got a chance to start some economic activities. They are two agro processing mills that are located almost at the centre of Bhujung VDC, four bakery shops, four-carpentry/furniture workshop and three TV/Radio repairing shops.
- The average student enrollments in secondary level before and after electrification are 31 % and 45% respectively. Similarly, the dropout ratios are 41 % and 52%

for boys and girls respectively before electrification whereas the same ratios seemed to have changed to 28 % and 37% respectively after electrification. The average pass percentage as obtained from the Resource Center and the District Education Office, Lamjung before and after electrification is around 25 % and 37 % respectively.

- Kerosene lamp and fuel wood for cooking have invited the different diseases like eye straining, head aching black sooth and respiratory diseases.
- Fifty six percent respondents said they were suffering from Respiratory Disease, 42 percent form Head aching, another 48 percent from eye aching and 36 percent from black soothing before the electrification. Now this scene seems to have changed to some extent. But as per the result of the study people suffering from respiratory disease, head aching, eye aching black soothing were 52 percent, 10 percent, 8 percent and 12 percent respectively. So it seems the rural electrification has played a significant role for improving the health status of the people of Bhujung.
- Eighty percent participants said that they used to use Dhiki/Janto for agro processing before the introduction of MHP that used to take lots of time. They also said that for that purpose almost daily they had to get up early in the morning (i.e. around 3.00 am). They had to work at least eighteen hours a day compulsorily. But now the case seems to have changed a lot.
- Almost 100 percent respondents said that they go to the agro processing mills for rice hulling, oil expelling and grinding millet, maize and wheat.
- Women spend less time for different agro processing works have got enough time to sleep at night, some time to take rest, some time to listen to the radio and watch TV in the evening. Similarly, they have got enough time to take care of their children. They said that because of this reduced workload there is improvement in their health also.
- Some 5 percent participants said that electricity has no effect in their household chores.
- Most of the respondents have TV sets and the cent percent respondents have Radio. Most of the Radios and cent percent TV sets are run by electricity.

- Micro hydro is not significantly contributing to conserve the forest that was one of the prime objectives of constructing this MHP.
- There is no negative environmental impact of Bhujung MHP.
- No other rural development activities have been started after the electrification. So rural electrification alone could not play a significant role for the overall development of the Bhujung VDC.

6.2 Conclusions

Following conclusions can be drawn form the present study:

This project seems to have some positive impacts on the education, health, and socio-economic condition of the users of Bhujung VDC but not to the extent to which it has to be.

- Peoples' living standard has not significantly altered after electrification.
- This MHP has reduced the drudgery of women and helped to improve their living standard.
- No direct relationship can be seen to have established between Rural Electrification and Rural Development. However, it has significant role.

6.3 Recommendations

On the basis of the study the following recommendations are made at local level-

- Awareness programs should be conducted among the local people about the benefits of micro hydro project
- Local people should be motivated for the increased use of micro hydro.
- Employment generating activities should be promoted.
- Rural development activities are very less .So these activities should be started and increased gradually on local peoples' demand.
- Some users need more power for heating and cooking purpose. So if possible the power production needs to be increased by the construction of new projects or by other means.

- At present the main use of electricity is only for lighting. So this trend has to be shifted to the other income generating programs.
- Whatever the changes (Education, Health, Socio-economic etc.) we have found out from our research work is only from the electricity use perspectives. So this can be further researched from other perspectives also.
- This research was conducted with the limitation of time, money and place. So, the same research can be done by taking longer time arranging more funds.

Similarly, from the result obtained following recommendations can be made for national level.

- Government policy should be directed to attract the new investments in MHP for private sector as well as to inspire community owned MHP for dissemination of MHP.
- Research and development works for MHP and rural development should be encouraged and motivated in Nepal.
- All necessary information about the micro hydro project should be made available form district level.

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ANNEX-A

QUESTIONNAIRE

Name: *Sex:*
Age: *Education:*
Occupation: *No of Family Members:*
Marital Status: *Caste:*

1.For what purpose do you use electricity?
(a) Household work
(b) Small scale industries
(c) Others specify

2. If household purpose in which purpose?
(a) Lighting
(b) Cooking
(c) Heating
(d) Others specify

3.If small scale industries for which type
(a) Agro processing
(b) Bakery
(c) Carpentry/Sawmill
(d) TV/Radio Repairing
(e) Others

4. In which of the instruments do you use electricity?
(a) Radio
(b) TV
(c) Battery Charging
(d) Water pumps
(e) Others

5. (i) Do you save money on battery charging?
Yes/No
(ii) How much money do you save after electrification per month?
(a) Rs 50-100 (b) Rs 100-150 (c) 150-200 (d) More than Rs 200

6.What are the major sources of energy in your locality for cooking?

Source of energy	Before Electrification	After Electrification
Biogas		
Firewood		
Solar		
L.P. Gas		
Others (Specify)		

7.How is the present electricity tariff?
(a) Very expensive
(b) Expensive
(c) Moderate
(d) Cheap

8.Do you feel any changes in the use of following energy sources?

Types of energy sources	Yes/No
Firewood	
Kerosene	
Solar	
Biogas	
LP Gas	

9. Do you feel any changes in the rural life after electrification?
Yes/No

10. If yes, what kind of changes do you feel?
(a) Rural infrastructures
(b) Rural education
(c) Rural health
(d) Economic Status of people
(e) Drudgery of women
(f) Others

11. Do you feel are there any new rural development activities started after electrification?
Yes/No

12. If yes what kinds of development activities, please mention.
(a) School/ College
(b) Roads
(c) Hospitals
(d) Others

13.Is there any change in school enrollment before and after electrification?

Before Electrification		After Electrification	
Fiscal Year	Enrollment %	Fiscal Year	Enrollment %
2049		2056	
2050		2057	
2051		2058	
2052		2059	
2053		2060	
2054		2061	

2055		2062	

14.Is there any change in the dropout ratio of boys/girls before and after electrification?

Before Electrification			After electrification		
Fiscal year	Boys	Girls	Fiscal Year	Boys	Girls
2049			2056		
2050			2057		
2051			2058		
2052			2059		
2053			2060		
2054			2061		
2055			2062		

15.Is there any change in class wise pass percentage before and after electrification?

Before Electrification		After electrification	
Fiscal year	Pass percentage	Fiscal Year	Pass Percentage
2049		2056	
2050		2057	
2051		2058	
2052		2059	
2053		2060	
2054		2061	
2055		2062	

16. What kinds of health problems were you facing before electrification by using kerosene for lighting and firewood for cooking?

Types of Disease	Before Electrification	After Electrification
Respiratory		
Black Sooth		
Eye Aching		
Headache		
Others		

17.What kind of health facility has been improved after electrification?

(a)…
(b)…
(c) None

18. (a) Has electrification helped improve the health condition of women?
Yes/No
(b) If yes how please specify.
(i) By reducing work load

(ii) By increasing sleeping time
(iii) By increasing time for taking rest
(iv) By providing time for entertainment
(v) Others

19.What sort of social changes you have felt after electrification?

(i) Use of modern instruments for entertainment (Radio/Tv/Casssette Player)
(ii) Duration of entertainment/ cultural programs increased
(iii) Increased Security
(iv) Reduction in crime rate
(v) Work in the evening
(vi) Others

20. Do you feel that the drudgery of women has been reduced after electrification?

21. Do you feel that is there any change in the economic status of the people after electrification?

22 (a) Do you feel any change in the use of fuel wood after electrification?
Yes/No
(b) If not why?

23. Is there any negative environmental effect of Bhujung MHP in the village?

24. After electrification form, which sectors you, have taken large benefit?

Sectors	Highly Satisfied	Satisfied	Unsatisfied	Not Satisfied
Education				
Health Improvement				
Economic Acticvities				
Infrastructure Develiopment				

25.Do you have any comments regarding the Bhujung Micro Hydro Project?

THE END