CHAPTER – I

INTRODUCTION

1.1 Background of the Study

Nepal is a naturally gifted landlocked country of South Asia which is located between two economically strong countries: India and China. It is roughly rectangular in shape with various natural resources at its disposal. Among these natural resources, hydropower is the one which is in abundance and has immense potential. Thus, in the context of Nepal, it is the best alternative among the sources of energy.

On the basis of potentiality of hydropower, 'Nepal is the second largest country behind Brazil in the world and is first in Asia. There are about 6000 river and rivulets flowing north to south. The total hydropower generation potentiality of these rivers is estimated to be about 83000MW of which 43000MW is economically and technically viable. Nepal's hydropower generation capacity is 2.77 percent of the world's potentiality (MOF 2009/10)".

The total hydro electricity generation at the end of three year plan 2010-2013 was 705 MW out of which 473 MW is produced by the NEA whereas 232 MW from private sector (NPC, 2014).The hydroelectricity generated by the mini and small hydropower plants has increased by 2453 KW in FY 2010/11,3258 KW in 2011/12,3258 KW in 3366 KW in 2012/13 and by 752 KW in first eight months of FY 2013/14 (MOF,2013/14).67% of the total population have access to electricity

Hydropower is a renewable source of energy that is considered to be the best alternative due to its cost effectiveness and pollution free nature. The topographical diversity and sloppy geographical structure within the boundary of Nepal has contributed in increasing the velocity of water flow that has enhanced the hydropower generation capacity.

The history of small scale and micro hydropower in Nepal began with the traditional water mills or ghattas used for grinding flour. Turbine for milling purpose account for more than 50 percent of the existing micro-hydropower schemes in Nepal at present (HEDON, Household Energy Network).The 500KW Pharping Power Plant which was

commissioned in 1911 is the first hydropower installation in Nepal. In 1936, the 640KW Sundarijal Hydropower Plant was commissioned and in 1965 2.4MW Panauti Hydropower Plant was installed.

The 92MW Kukekhani Hydropower Plant (I&II) commissioned in 1982, is the only project offering seasonal water storage in Nepal. The 144MW Kali Gandaki 'A' Hydropower Project, commissioned in 2003, is the biggest hydropower in Nepal so far. Most of the hydropower plants in Nepal are owned by the governmental agency called Nepal Electricity Authority (NEA).

Energy is an important aspect of economic development of rural as well as urban sector of a country. Lack of energy often hinders people from achieving economic progress and better lifestyle. Though, there are not sufficient hydropower plants in Nepal, the existing ones have been providing their services to the people. These plants have been very helpful in providing assistance to the people for their better life style and economic prosperity.

Nepal is among the poorest country of this world with approximately 21 percent people living beyond poverty line (NPC, 2010). Most of the poor are peasant farmers living in rural areas .To reduce poverty, improve education as well as health standard and to improve overall living standard of these poor hydropower can play significant role by supplying reliable and sustainable energy to economic development.

One of the major reasons for poverty and backwardness of Nepalese economy is power deficit. Shortage of power creates a problem in the development of agricultural, ,industrial, trade and other sectors of the economy. With a view to meeting the power shortage, it is needed to generate power not only at the medium and mega level but also at the small level so that each can prove to be complementary rather than competitive to one another.

The small hydropower may play a crucial role in increasing production and productivity of the agricultural sector, including the processing of agriculture product. Lift irrigation in the hills may also be promoted in a meaningful way through the development of small hydropower. Additionally, the food processing and cottage industry might benefit a lot from the development of small hydropower.

Although, hydropower is considered a major natural advantage for Nepal, its development has been extremely challenging. The challenges are directly related to technical, economic, social as well as political problems in Nepal. Technical problems are related to country's geographical, topographical and hydrological features that provide large complication for the development of hydropower projects. Government instability is also a serious issue in development of this sector.

1.2 Statement of Problem

Nepal is a underdeveloped country with its major fraction of population dependent on traditional and subsistence natured agriculture. The main source of energy in rural habitat is of traditional nature whereas the urban have the luxury of using electricity and other sources of energy.

The dependence on the traditional source of energy has straight effect on the livelihood. It has negative impact on health and education particularly that of women and children. It has hindered the proper growth of education as well as health related facilities.

The use of firewood as cooking fuel always affects the health of those exposed to smoke which ultimately is a cause of various airborne disease. The lack of electrification also has negative also has negative impact on education of overall population as electrification has positive relation with various education indicators.

One of the major problem in the development of the micro and small hydropower plants has been the sustainability .The sustainability of the micro and small hydropower projects has been given little importance and the study on this regard has been limited.

Thus, in the context of Nepal, electrification of rural area through the installation of MHP is the best alternative. Electrification is the best way to give economic upliftment, better health, education and better lifestyle.

1.3 Objective of the Study

The general objective of the study is to explore the impact of electrification through small hydropower plant in the socio-economic aspect of rural people through income, savings and income generation. The specific objectives of the study are as follows:

1. To explore the impact of Andhi Khola Hydropower plant on health and education in Arjun Chaupari VDC of Syanja district.
2. To assess the present status of sustainability of the micro-hydropower plant.

1.4 Significance of the Study

Energy has always been a vital factor of development. In the context of Nepal, hydroelectricity is one if the source of energy that has potential to accelerate the economic development. Although, it has potentiality, its development has been extremely challenging. The challenges are directly related to technical, economical, social as well as political problems in Nepal. The problems are enhanced in case of large hydropower plants.

The hydroelectricity generated by existing mega hydropower plants are connected to the national grid that are utilized mainly by the urban area and thus have limited in his context, small and micro hydropower plants play a significant role in uplifting the employment and income as well as health and education of rurals. However, there are many constraints in the initialization as well as smooth functioning of small hydropower. Studies in the development and sustainability of small hydropower projects in Nepal have been limited. Thus, it is worth analyzing the status and impact of small hydropower in terms of its end use efficiency and uplifting the economic, health and educational status of rural people.

The conclusion of this study can be a significant tool for the policy makers to drive them towards the formulation of appropriate policies for the proper and sustainable development of hydropower plants. The result can also be helpful in gaining the information about the positive of electrification on various socio-economic aspects. The result can also be helpful to other scholars and institution to know the externalities of such projects on the rural areas. The study will be fruitful in exploring

the overall socio-economic impact of small and micro hydro power plants in rural areas.

1.5 Limitation of Study

This research is a part of academic degree. It is mainly focused on the socio-economic impact of small hydropower project in development of Nepal. Aadhi Khola Hydropower has been taken as a case study of this research. The study mainly focuses on impact of Aadhi Khola Hydropower on health and education at the local level. It also focused on finding the problem regarding its sustainability. The conclusion derived from this study may not be equally applicable to other sectors. Due to the financial, temporal and other constraints, the field survey is conducted only in a single season.

1.6 Organization of the Study

This section deals with how the chapters are organized hereby. Altogether this study is divided into five chapters. The first deals with the general background, statement of problems, objectives, significance, limitation and organization of study. The second chapter is about the review of literature. The third contains study site, nature of data, sample selection, questionnaire design, method of data collection. The fourth chapter with findings and analysis of data and its presentation. The fifth contains summary, conclusions and recommendations.

CHAPTER – II

REVIEW OF LITERATURE

2.1 Introduction

The last two decades have generated interest in the development of small hydropower due to its superiority over mega hydropower in the aspect of environmental effect, sedimentation rate and the ability to produce power in and for remote areas. Small hydropower has less abusive environmental effect, are economically viable and have relatively short gestation period. Thus, small hydropower do not face the constraints that the mega hydropower projects face. The renewed interest in small hydropower have attracted a large number of researches to examine the social as well as economic impact in rural areas, Accordingly, a number of studies have been carried out in this field in different countries. However, studies about the socio-economic impact of small hydropower projects on rural people is lacking. In this context, there is a need to examine the socio-economic impact of small hydropower projects in rural Nepal. Section 2.2 presents the review of some of the studies carried out in the related field.

2.2 History of Micro Hydro Power in Nepal

2.2.1 Introduction of MHP

Micro-hydro systems have been in use in the Nepalese hills for centuries in the form of horizontal water wheels which are traditionally known as “pani Ghatta”. Some 25,000 of these ghattas are estimated to be in operation. However, they have only limited application and produce about 1 horsepower, just sufficient for grinding maize and millet. With the development of cross flow turbines in 1961 and multipurpose power units (MPPU) during the early 1980s. The available hydropower in increasingly used for rural application. Because of the rapid increase in the price of fossil fuels and the problems of distribution in the hills and mountains, the efficient use of water turbines and MPPUS became the focus of attention in rural communities. In Nepal the classification of hydroelectric plants according to their capacity is as follows.

Categorization of Hydropower

Type	Size
Micro-hydropower	Up to 100 KW
Mini- hydropower	Above 100 KW But not exceeding 1000 KW (1 MW)
Small- hydropower	Above 1MW But not exceeding 10 MW
Medium- hydropower	Above 10 MW But not exceeding 300 MW
Large- hydropower	Above 300 MW

Hydro powers up to 100 KW are known as micro- hydropower. Water power can be converted into mechanical energy by using water turbines and into electrical energy by using electricity generating equipment.

The major components of MHP re diversion, intake, descending basis, canal, fore bay, spillway, penstock, powerhouse, tailrace and transmission distribution system. Dis-service structure is a structure designed to raise the water level in the stream in order to enable water to be diverted off the river. In MHP, as a rule, only temporary structures are built for this purpose. These structure are in most cases simply consists of boulder, mud pilling recombining he diversion practiced in traditional water mills. In some cases gabin wires are also used for diverting water. Intake is the point from where water flows off the river channel. Therefore intake is the beginning of the conveyance of water diverted for MPH. Intake is normally provided with a gate to control the quality of diverted water. Canal is the structure designed to deliver diverted water to the fore bay of the MHP. In MHP sometimes pipes substitute canals. In hydropower the conveyance for deliver of water from river to the fore bay is called headrace, penstock is a pipe for delivering water from the fore bay to the turbine. It is made of steel, rarely of timber. The conversion of potential energy of water in to kinetic energy takes place in the penstock. The typical velocity of water in the penstock is around 3m/sec. The order to reduce the head loss in penstock it is desirable to make the penstock as short as possible. For this purpose penstock is located in a steep slope, which is very often over 45 degree conversion of mechanical energy of water into electrical energy takes place in the powerhouse. The major components are electrical generator, turbine electronic load controller and control panel. Electrical generator is a device, which converts mechanical energy input to its shaft into the electrical energy. Conventional pants use synchronous generators. MHP use both synchronous and asyn-

chronous generators. Turbine is a device, which converts kinetic energy of water into kinetic energy of turbine shaft, which drives the generator shaft. The turbine types widely used in MHP in Nepal are pelton and cross flow. If cross flow turbines are used as lower heads the pylon turbines are used at higher heads. In stand-alone MHP pelton wheels are dominant owing to the prevalence of higher heads.

2.2.2 MHP Development in Nepal

The micro hydropower sector in Nepal has a long history. The efforts to modernize traditional water mills started in 1960s. The history of micro hydropower development started with the use of the locally developed water mills which are called “ghattas” which typically have power of 1to 3 K. W.

The institutional development of the MHP sector started dates back to 1960s when Swiss assisted the establishment of a manufacturing company named Balajuyantrashala in Kathmandu. United Mission to Nepal (UMN) initiated establishment of institution to support rural technology development. Mostly locating in western part of the country in the beginning of the 1970s. There were some other private workshops established primarily to product and install small units, widely known as “turbine mill” in rural Nepal.

The first MHP were of add-on types. Some of these used simply dc dynamos. The capacity of add-on type of MHP seldom goes beyond 5 KW. These MHP are by and large,

Designed to supply power to lighting end uses. Stand-alone MHP appeared in those places, where there was no milling need or where the MHP site was far away from the settlement or the power requirements were much higher than that add-on MHP could meet till 1984. The imitative for promotion for MHP was made mainly outside the government sector. During the above period significant contribution for promoting the MPH/turbine technology were made by Kathmandu mental industries, BalajuYantrashala, Butwal Engineering Works, Development Consultancy Services (DCS), Research Center for Applied Science and Technology (RECAST), Swiss Association for Technical Assistance SATA) and other organizations. There were basically three players who contributed to development of micro-hydro sector in Nepal at the begin-

ning namely the Agricultural Development Bank (ADB), the private manufacturing companies and rural communities or entrepreneurs.

In 1984 the government with a view to promote MHP waived the license requirement for it. The electrification from the micro-hydro structure after 1985 when government announced a providing for the subsidy primarily on adding generator to existing turbine mills and also some new schemes were built for the stand-alone electrification purpose. A quick progress was witnessed in a short period of time. The government further provided incentive to the entrepreneurs by waiving income tax on earning from MHP, with a view to improve access to capital for MHP entrepreneurs the government, through the ADB/N, started providing load for MHP under the priority sector interest rate. After this arrangement the ADB/N played a key role in promotion of MHP. After the liberalizations of economies, the year 1990 saw a turning point for the development of MHP plants in Nepal.

With is policy introduction by the democratic government 1990 and a technological breakthrough in Micro-hydropower, progresses emerged and may plants come into widespread use that made it possible to generate electricity from the traditional water mills in addition to milling grains. Private sector is attracted due to the affordable investment opportunities. Since the collapse of Arun-III project in 1995, the necessity and importance of development of micro-hydro further developed. The donors have designed an alternative strategy as power development fund. Act and regulations were and are being rewritten to attract the private sector. The effort for development of MHP is continuing to date. The organizations that have joined later in the development of MHP are Remote Area Development Committee (RADC), Intermediate Technology Development Group (ITDG/N), Centre for Rural Technology (CRN/N), WECS, UNDP, DANIDA, AEPC, Micro-hydropower manufactories Association, REDP, Annapurna conservation area project KMTNC, GTZ, USAID and Canada Co-operation Office (CCO) Institute of Engineering and others. MHP development has received a new dimension despite few hurdles due to the political instability in the country.

2.2.3 Present Status and Potentiality

Nepal's topography is quite unique with high hills scattered settlements. It is estimated that in Nepal more than 6000 rivers and innumerable rivulets cross- crossing the country, whose total length is about 45000 K.M. The total hydropower generation capacity is found to be 83000 MW though the economically and technically viable production capacity is 43000 MW only (Trade Promotion Centre,2002).Water power is the most abundant sources of energy besides the firewood in the hills. Forest supply nearly 76 percent of total energy requirement of the country and was provides 50 percent of fodder for livestock.

2.2.4 Government Policy and Major Institutions

The importance of developing water turbine was felt during both the sixth and seventh five year plans. The fifth five year plan (1975/76-1979/80). For the first time, considered the role of micro-hydro plants in rural electrification according to the plan was to promote expansion of agriculture, commerce and small-scale industries under the guidance of the plan, the small hydro-power development board was established in 1975, which played a crucial role in the electrification of rural hill areas. Under the sixth five year plan period ADB/N, institute in 1981, the rural electrification through micro-hydro power plants.

In 1984, HMG/N delivered MHP up to 100 KW to encourage the participation of private sector in rural electrification. The development of the energy sector was given special priority in the eighth five year plan. The existing policy, no-license is required to operate a hydropower of up to 10 MW capacity, this scheme plays significant role for development of MHP. The owners are given liberty to fix tariff rates of their schemes. HMG/N formulated a hydropower development policy in 1992.

After the establishment of Energy Support Assistance Program (ESAP) with the support of DAINIDA and NORWAY, the subsidy policy as well as increased investment in the construction of micro-hydropower and to facilitate more homes, a new rate of funding has been decided. This encourage to include all the homes of the community and therefore this policy is inclusive also.

Subsidy Mechanism of Government of Nepal for MHPs:

Feasible Mini-Grid Schemes will be eligible for the government subsidy which is channeled through the REF in accordance with the GoN subsidy policy. The GoN has recently approved the new subsidy policy for Mini-Grid projects/schemes which sates the following provisions:-

1. Rs. 12,000 per household but not exceeding Rs. 97,500 per KW of installed capacity for projects up to 5kW.
2. Rs. 6,000 per household but not exceeding Rs. 60,000 per kW for the electrification from improved Water Mills.
3. Rs. 15,000 per household for new plants between 5kW to 500 kW but not exceeding Rs. 125,000 per kW of installed capacity.
4. For rehabilitation projects above 5 kW, subsidy equal to 50% of rehabilitation cost will be provided but not exceeding Rs. 62,500 of verified per kW.
5. Rs. 97,500 per kW for projects up to 5 kW for institutional establishment.
6. Additional transport subsidy of Rs. 500 per kW but not exceeding Rs. 30,000 per kw for projects situated at more than 10km from the nearest road head.
7. Rehabilitation projects will receive 50% for transportation subsidy.
8. Rs. 30,000 per km will be provided to the Karnali Zone and the prescribed adjoining areas of Achham, Bahang, Bajura, Dailekh, Darchula, Dolpa, Humla, Jajarkot, Jumla, Kalikot, Mugu, Rolpa and Rukum districts.

Subsidy Delivery Modality:

Depending on the size of the project, the project cycle shall entail identification, verification, feasibility study by qualified companies and appraisal of the project by MGSP and TRC. If the outcome of the appraisal is positive, the Mimi- Grid developer will be eligible to apply for the subsidy as in the standard REF Application Form. After commissioning of the project, MGSP verifies the commissioning and power output test reports.

Other Supports from Government level:

Other supports from Government of Nepal can be summarized as follows:-

1. Technical Human Resource Development through different technical trainings
2. Encouraging Private Sector through the provisions of Pre-Qualifying process for installation of MHPs.
3. Appointment of Facilitator Organizations (NGOs/Companies) for facilitating the community about government efforts incuding subsidy mechanism.
4. Coordinating efforts from different private sector, NGOs, INGOs, giant bilateral and multi-lateral donor agencies and UN and its associates and gathering sufficient fund for the promotion of MHP countrywide, etc.

2.3 Review of Empirical Studies

Acharaya (1983), 'Hydro Electricity Development in Nepal and its Contribution to Nepalese Economy', mentioned that Nepal still got success to explore the available water resources. It is analyzed that the Hydro-electricity is the most useful resource for economic development in Nepal. It is the backbone of the industry, agriculture, transportation and is the most useful for the social service purpose. The water potential of Nepal is its greatest assets. Nepal is facing many problems in the hydro-electricity development because of the lack of capital, manpower, technical knowhow and sufficient market in the country. Beside this the most important problem is poor planning in Hydroelectricity development.

Macaa (1987), have examined the operation and maintenance of hydropower installation in rural Nepal. He has concluded that small and micro hydropower projects encounter less developmental problem in comparison to large hydropower plants. He has concluded that the traditional economic scale that would dictate large hydro schemes will cost less per installed kilowatt than small project.

East Consult (1990), analyzes the socio-economic impact of MHP plants on rural economy of Nepal. This study is more related to the issues of mill ownership's and management performance such as mechanical agro-processing and electricity, it impact on both entrepreneur and consumers. According to the findings of the study, the

electricity has provided psychic and indirect benefices such as longer hours of study, improvement of health, some wicker work's etc. and has been made be community more attractive for transient such as trekking but the economic productivity can not be expected since the sue of electricity is not predictive. Tariff collection problems, lack of knowledge in operating and maintenance and authorized use of electricity are identified in the problems side. The rural people have no cash income to pay the electricity change. So, it is very much difficult for them.

It has been amply demonstrated that decentralized micro-hydro schemes could play an important role as a viable source of energy. In order to expand this program to a significant scale, more research and development efforts are required to lower the investment required for the micro-hydro system by reducing the manufacturing cost of agro-processing equipment, to integrate its use with cottage and rural industries, and to improve the efficiency of traditional "ghattas" and increase the scope of their use. A number of other important issues also need to be addressed, how can its operation be expanded? How can private sector capabilities be enhanced to cope with increasing demand? Is the current institutional mechanism appropriate? How can commercial banks and government developments play a more active role? There seems to be a services lack of government interest regarding the development of MHP in Nepal both in terms of policy planning as well as implementation. The quantitative targets in the 10th Five year Plan is to produce 10 MW from micro hydropower in 47 distinct and install 4.000 improved ghatta (10th Five Year Plan 2002)

WECS (1994/95), Report has analyzed, the main feature of the energy section in Nepal is the growing imbalance between energy resources endowment and its current use. Heavy reliance on the forest resources to meet the growing energy needs despite abundant unexploited hydro-power potential indicates a serious limitation to achieving the increase in the level of energy consumption necessary for higher economic growth and sustainable development. The present deficit in the fuel wood supply (6.66 million tons) is expected to continue given the excessive human and livestock population pressure on the accessible forests. Estimates indicate that the deficit will be concentrated in the Terai and Middle Mountains, home to 85 per cent of the population. Report has also found that the present energy situation needs to be rectified to allow the country to achieve its development targets. To maintain the ecological balance and to

make energy resources sustainable, there is a greater need to gradually move away from forest based energy sources. An attractive option, among many others, would be to resort to alternative energy technologies which have the inherent ability to perform effectively under such arduous conditions.

Jha (1995), has examined the cost effectiveness of small hydropower in Nepal. He stated that one of the major reason for poverty and backwardness of the Nepalese economy is due to power deficit. He has concluded that small and micro hydropower play crucial role in increasing productivity of the agricultural sector, including the processing of the agro products. He has also concluded that the hydropower is also important from the consideration of national welfare in diverse fields such as conservation of forests, creation of self-employment opportunities and also promotion of the tourism industry.

ICIMOD (1998), Report, has been carried out some case studies on renewable energy technology. Study highlighted the importance of micro-hydropower in terms of reducing drudgery for women, as it reduced the time taken in agro-processing activities and also provided opportunities for women to engage in income-generating activities and literacy classes in the evening. Regarding legislative and regulatory issues, the study highlighted some points. Such as, the water resources act 1996 did not specify the right of prior use of water resources form micro-hydropower projects; the private sector shied away from research activities because of the inadequacy of laws on patent and intellectual property rights lack of formal standardization of procedures and guidelines and resulted in errors in flow measurements and demand estimation at the feasibility study stage of project, as well as negligence regarding safety features in micro-hydropower plants and entrepreneurs often found it difficult to get financial assistance from ADB/N for micro hydro if a diesel mill or other water turbine existed within three kilometers of the vicinity. This has not only affected hydropower development but also created situation of monopolies.

ICIMOD (1999), Report pointed that, in the past, the implementation of alternative energy technologies has not been very encouraging. Despite-there attractive economic and financial performance, potential in the overall energy scenario is still unrealized. A number of issues have emerged related to their development. The issues can broadly be classified as social issues (non-acceptance of technologies), planning and policy

issues (lack of willingness at, the policy level), institutional issues (non-existence of responsible coordinating bodies), financial issues (high initial investment) technical issues (weak infrastructure), and managerial issues (lack of marketing skills).

Rijal (1999), shows that traditional energy forms predominate in the energy sector in Nepal. About 91 per cent of the total final energy consumption (260 million GJ) in 1994/95 was met by traditional forms of energy such as fuel wood 81 per cent, agricultural residues 4 per cent and animal waste 6 per cent, the rest came from commercial sources such as petroleum products 7 per cent, coal 1 per cent and electricity 1 per cent. There has been little change-in energy transformation over the last decade. The share of traditional energy has declined only marginally, from about 95 per cent in 1984/85 to 91 per cent in 1994/95.

Dhungel (2002), in the article, 'trends and patterns of energy consumption in Nepal' has mentioned that main sources of energies are biomass (traditional), which constitutes fuel wood, agriculture waste, animal dung etc. and commercial sources which constitutes coal, petroleum products, hydro-electricity etc. Energy consumption in Nepal is dominated by biomass which accounts for 95%, 94,9%,91.7%,86,4% and remaining shares the commercial energy in FY1984/85, FY1989/90, FY1995/96 and 2000/01 respectively. Average growth rate of biomass and commercial energy consumption during the FY 1984/85- FY 2000/01 were 2.1% and 10% respectively. Similarly, commercial energy consumption was growing by more than 5% per annum. Annual growth rate of fuel wood, coal, petroleum products and electricity during the FY 1984/85 to FY 2000/2001 were 2.7%, 27.2%. 12.7% and 10% respectively. Income elasticity of electro products consumption and electricity were 1.75% and 1.14% respectively. By assuming 2.24% population growth rate and 4% economic growth annually, he predicts that energy consumption increase by 4,2% per annum during the FY 19994/95 – FY 2004/2005.

Dhital (2003), this is the conference paper presented in international conference on renewable energy technology for rural development (RETRUD 03) prepared by Dhital, Ram Prasad. The RETRUD report is published in every four years. It is important information to the energy sector, which combines the present states, past experience and future plan of this energy sector with the view of national and foreign experts. The paper tries to analyze the initial evaluation of investments and optimizes the

components to observe on total projects cost. This analysis deals with the approach for financial analysis to calculate the cost where three scenarios that is, with subsidy, without subsidy and with net economic benefit.

Sharma (2003), expressed in his book about the overall macroeconomic aspects and their scenes of Nepalese economy. He explains about utilization of water sources and its role in economic development. He mentions about hydropower potentiality and development of hydropower in Nepal. Pharping (500 MW) is the first installed hydropower project in Nepal. The total electricity generation capacity was 2,077 KW before the initiation of economic plan (1956). Sixth plan brought out new vision in the development of small hydropower project. He mentioned the installation of all scale projects up to that date. Similarly, HMG brought out new policy to develop water resources and hydropower as well. Consequently, private sector has been encouragingly investing in the development of hydropower. It has mentioned region wise distribution sector-wise consumption of power within Nepal. Until 2001, there was 62.6 percent (which is in top position) of total generated capacity in CDR installed. Similarly, WDR, MWDR, EDR and FWDR occupied 30.3 percent,3.0 percent and 0.5 percent of the total generated capacity developed respectively up to the same time. It seems that most of the total capacity is used by the household sector, commercial sector, which are 95.6 percent and 2.3 percent respectively. He points out that some problems related to the hydropower, for sustainable development of hydropower. He suggests solving the debate between Nepal and India to make and implement appropriate policies about water resources, to reduce cost, leakages, integrated approaches and national commitment. In short it requires suitable policy and programs to develop small and middle scale projects to meet national demand for electric power and it can be suitable alternative measure to reduce power imported from India.

RETURD (2003), states that, renewable energy sources are indigenous and can contribute towards reduction in dependency of fossil fuels. It also provides national energy security at a time when decreasing global reserves of fossil fuels threatens the long-term sustainability of the economy. Renewable energy serves assume special significance in developing country like Nepal when viewed in the context of the geographic diversity and size of the country, not to mention the size of its rural economy. Since the renewable energy resources are appropriate as local energy sources meeting

ever expanding and diversified energy needs. In this perspective they offer numerous possibilities for meeting the basic energy needs of the rural poor. Thus, the increased use of renewable energy sources/technologies is necessitated by the ability of the conventional systems to meet growing energy demands in an equitable and sustainable/manner, need to efficiently and economically meet the energy needs of all country's citizens, particularly the rural poor, large-scale impact of conventional energy, production and consumption on the physical and human environment.

Saud (2005), in his study 'Development of Micro Hydropower in Nepal' has examined the contribution of MHP in rural development and access the impact of MHP in people's quality of livelihood in remote areas of the country. He concluded that has a great contribution to reduce the demand of traditional fuel in the isolated areas of the country. Further, this study has concluded that such hydropower projects have played a significant role in increasing the income level and reducing the level of poverty and raising the literacy rate.

Ghimire (2007), in his paper "Small Hydro Development Opportunities and Present Status in Nepal" state that Nepal as predominantly an agricultural economy and about 85 percent of the economically active population is engaged in agriculture. Still 80 percent of the energy need of the country is met by the traditional energy sources such as fuel-wood, agro-residue and animal dung. It is estimated that only 40% of the total population of around 26 million has electricity through different sources like national grid, isolated small and mini hydro systems as well as solar home systems so far. But, most of the population living in rural areas using electricity mainly for lighting purpose. This paper basically gives insights on opportunities of small hydropower with regard to hydropower development and present status in Nepal. It is also focused on energy supply situation with regard to hydropower development. Electrification programs will be made extensive to augment the development and expansion of agriculture production and of cottage and small-scale industries in the mountain and Terai regions of the country. For the implementation of these program, small and mini hydropower plants will be developed where electrification can't be provided through Inter Connected Nepal's Power System (INPS). Hydropower as a non-polluting. Environmentally friendly, renewable, locally available and reliable source of energy needs to be exploited to the fullest potential possible. To meet the national energy objectives, small scale hydropower plants are effective for the electrification of remote isolated areas. In due course, these plants can be interconnected and make local grid system. Thus, reliability and stability of power grid can be achieved from unique operating characteristics of hydro-power isolate.

Gurung et al. (2011), in their study, “Socio-economic Impacts of a Micro-hydropower Plant on Rural Livelihood” have examined the contribution of MHP on rural development. They concluded that village electrification have brought significant positive change in rural livelihood. Results revealed that children have less propensity to go for wood collection once their home have been connected to MHP. Traditional kerosene lamps like Tuki and Panas were completely abandoned and firewood consumption was reduced. Electric lights in household extended the day by providing additional hours for evening reading and work. The micro hydro based electricity was used to power modern agro-processing mills in village which reduced drudgery for women. They also concluded that that hydropower based electricity reduces carbon dioxide emission significantly. Thus, the study comes to a conclusion that MHP provides clean, affordable and sustainable energy both locally and globally and has positive impact on socio-economic condition of rural communities.

Joshi (2011), in his thesis “Socio-economic Impact of Surma Devi Small Hydropower Project: A Case Study of Bajhang district” has mentioned that energy is important for economic development. The pace of economic development cannot be accelerated without hydropower development. The development of productive sector of an economy depends on development of the energy sector. In the hilly and mountainous area, almost all the households are found to have consumed traditional sources of energy for cooking, heating, lighting and other necessary activities. Traditional energy sources cannot be sustainable to fulfil energy requirement. From the present analysis it has been observed that most of the people depend on forest for energy sources and livestock. As a result, the deforestation has brought about ecological and environmental hazards along with shortage of fuel wood, soil erosion, deterioration of the fertility of soil etc. Deforestation leads to the deterioration of water sources and hampers both electricity generation and drinking water. Hydropower occupies a very eminent place in the energy sector of Nepal. The utilization of energy is concentrated on urban areas and most of the rural areas have been by-passed-by this power development. The hydropower project has brought about changes in socio-economic, cultural and other aspects of the people living in the project located area and its surroundings .To find socio-economic impact and to introduce the total effect of the project at the study area is main objective as well as quantitative method is used the study find the every kinds of socio-economic and environmental effect in the study area as well as surrounding area.

CHAPTER – III

RESEARCH METHODOLOGY

This chapter discusses the methodology of the study. The whole study has been carried out on the basis of primary as well as secondary data. Reliable and relevant study can be made possible only by applying scientific method. Hence, the primary purpose of this chapter is to discuss and design the framework for the research.

3.1 Introduction of the Study Area and Project

Syanja district, a part of Gandaki zone, is one of the seventy-five district of Nepal, a landlocked country of south Asia. The hydro-power project, Andhi Khola Hydro-power, is situated at Jagtra Devi VDC of Syangja district with its electricity generation capacity of 5.1 MW. The electricity generated through this project has not been connected to the national grid and has been providing power to majority of the area of Syangja district.

This project which has won the prestigious “The Blue Planet Award” was constructed by Himal Hydro including the works transmission line during the period 1992-1990. This exemplary hydro project divert the water from Andhikhola River to the Kaligandaki river through 1.23KM long headrace tunnel, 250M deep drop shaft and 1.02KM long tailrace to generate 5.1MW power.

This study mainly focuses on the impact of electrification on the health and education of women and children. This hydro-power plant has its impact on almost all part of syanja district but Arjun Chaupari VDC has been chosen as the study site which lies to the western part of the district. It takes about three hours to reach district headquarter from the site.

3.2 Research Design

This study is carried out on the basis of descriptive and exploratory research design. This study investigates the socio-economic impact of micro hydroelectricity on rural sector as well as the status of sustainability of the project. This study tries to find how people are benefitted by project and its impact on people. Thus, the study is explanatory research.

Besides the study an attempt to describe the things related to micro hydroelectricity such as running mills, furniture, communication, entertainment etc. Thus this study is descriptive, analytical and explanatory.

3.3 Nature and Sources of Data Collection

This study aims to explore the utilization of hydroelectricity and socio-economic impact of this project on the people of that very VDC. So, this study is based on qualitative and quantitative data from questionnaire through household interview survey. Thus, the primary data was collected from user households of the study area. Similarly the secondary data also be used for the study which was collected from different sources such as economic survey, CBS report, publication of Nepal Electricity Authority (NEA), publication of Alternative Energy Promotion Centre, feasibility report, journals, internet ,documents from individuals, experts and organization related to micro hydroelectricity.

3.4 Sample Size and Sampling Procedure

The total number of 225 households in seven different ward numbers are benefitted by the project. Out of households 45 have been picking up for the sample size using systematic random to fulfill the purpose of the study. The respondent of this study are indigenous people, professionals and students, businessmen, and commoners to get the data for the information about their social-economic aspects.

3.5 Data Processing

A worksheet was prepared through the complete questionnaire incorporating the use of electricity to purpose of its impact on economy, health condition, education, sources of energy, productive work etc. The collected data is classified according to its nature and characteristics. To make the analysis more reliable and easier, different data sheets have been prepared for different variables. The data will be carefully edited, processed and tabulated to obtain desired outcome.

3.6 Data Collection Tools and Techniques

For this study, data about the effectiveness of the electrification has been collected through direct personal interview with the help of structured questionnaire among di-

rectly project affected families (PAFs) in the society since the electrification. The structured questionnaire or unstructured interviews and observation methods was applied to collect the both qualitative and quantitative data in the survey.

3.6.1 Questionnaire Survey

To generate the accurate data from HHs survey of micro hydro users, structured questionnaire was prepared. The respondents were requested to fill up questionnaire. In case of respondents, who couldn't fill up the questionnaire had asked to the respondents and answer was filled up to collect the required information.

3.6.2 Field Visit and Observation

Field visit was conducted by collecting the name lists of each household who were benefited by hydroelectricity and selection was done by random sampling method. The selected sampling was visited and observed.

3.6.3 Key Informant Interview

As the micro hydroelectricity is the best tool to combat with the energy crisis in Nepal. This study conducted as the exploratory method. To dig out its reality key informant interview was applied to informed people within the sampling.

3.7 Presentation and Data Analysis

The data has been tabulated and analyzed according to the objective of the study. The data analysis is descriptive as well as analytical. Data was analyzed with the help of computer programme. Simple statistical tools like tables, graphs, pie chart was used for data analysis. Descriptive methods be used for qualitative data.

CHAPTER –IV

FINDINGS AND ANALYSIS OF THE DATA

This chapter presents the impact of the project on the study area. This study has examined the impact on education, health and the aspects regarding the sustainability.

4.1 Sex Ratio of the Study Area

Sex ratio is the number of males per 100 female. The following table shows the sex ratio of the study area.

Table 4.1

Sex Ratio of the study Area.

Age	Male	Female	Total	Sex Ratio
0-14	28	39	65	71.79
15-59	69	74	138	93.24
59 above	11	13	21	84.61
Total	108	126	234	85.71

Source: Field Survey, 2014..

The total population of 45 household was found to be 234 out of which 109 are male and 126 female. This shows that 46.15% are male whereas 53.85% are female. The sex ratio for total population is 85.71% female per 100 male.

The sex ratio is different with the variation in age group. The sex ratio for the age group 0-14 is 71.79, for the age group 15-59 years is 93.24 and about 59 years is 84.61 in on average there about 5 members in is household of the study area. The maximum population among the different age groups that of 14-59 years.

4.2 SHP and Health

Electrification has undoubtedly revolutionized the life style of the people. The life standard of the people has been upgraded. Before electrification the use of modern innovations in livelihood was minimal whereas after electrification there is an in-

crease in the modern appliance in every aspects of living which has brought positive impact of the health condition of people.

4.2.1 People Suffering from Disease by Age Sex

The study area is village town with a health post in the VDC. People usually are not found to be serious about their health. They have a habit of hiding their problem. After electrification they are gradually motivated in curing their disease by visiting the health institution.

Table No 4.2.1

Numbers of members affected by different disease by sex and age

Age	Number of people	Number of people affected	
		Male	Female
0-14	65	9	13
14-59	138	4	7
60 above	21	3	5
Total	234	16	25

Source: Field Survey, 2014.

Among the total population of 234, 41 of the people were round infected with some kind of disease. The age group 0-14 years is the most affected whereas the age group 14-59 age is least affected. It is also found that female are more affected then the male. Among the 65 people of age group 0-14, 9 males and 13 females were affected by some kind of disease; among the 138 of age group 14-59,4 males and 7 females were affected whereas among the 21 people above 60 years, 3 males and 5 females were found to be affected.

4.2.2 Number of People Suffering from Different Disease

The number of health institution and private clinics have also considerably increased after electrification. With the help of electricity, usage of some device has been initiated for the diagnosis of disease as well as treatment of patients.

Table 4.2.2

Disease and numbers of people suffering from it

Disease	No. of people Affected	
	Before electrification	After electrification
Running nose	9	6
ENT Initiation	4	5
Sinusitis	7	3
Asthma	11	4
Bronchitis	14	15
Pneumonia	7	6
Others	12	2
Total	64	41

Source: Field Survey, 2014.

The number of people suffering from different disease has decreased after electrification from 64 to 41. People suffering from Bronchitis and ENT Irritation has increased after electrification whereas number people suffering from other disease have decreased.

4.2.3 Days Spent in Hospital to Cure Disease

From the data collected is it found that people residing in the study area of the project have spent more days in hospital after electrification than that before electrification. Out of the 45 household surveyed; most of the household member were found to be suffering from air-bone disease whereas water bone disease like pneumonia, typhoid also has some impact.

The number of absent days for households wake has also modern due to more are in the number of days spent in hospital.

Table 4.2.3

Time spent in hospital and absent days for the household work

Average days spent in hospital		Days spent due to the illness in average	
Before Electrification	After electrification	Before Electrification	After Electrification
6.9	11.3	9.4	13.9

Source: Field Survey, 2014.

The above data shows that the days spent in hospital has increased which has also increased the absent days for household work. This may be due to the increasing number of health institutions as well as awareness regarding health.

4.2.4 Expenditure pattern to cure disease

Expenditure in curing the disease has increased after the identification of disease. The table shows that in an average there is an increase in the amount of money spent in curing the disease after electrification. It shows that most of the people have got opportunity to check their health which has resulted in increase in health expenditure.

Table 4.2.4

Expenditure pattern of surveyed household before and after electrification

Expenditure of household in average in a year(in Rs)	
5733	7933

Source: Field Survey, 2014.

The table 4.2.4 depicts that on an average in a year the expenditure has increased from Rs.5733 because of the identification of disease. This increase in the health expenditure can be due to the awareness gained by the people of the study area as well as the increase in health institutions.

4.2.5 Number of Visit to Hospital

The number of people visiting hospital has decreased after electrification but the percentage of people visiting the hospital has increased .Out of the 64 people affected by

some disease before electrification only 31 visited the health institutions whereas after electrification, among 41 affected 29 visited the health institution.

Table 4.2.5

Number of visit to hospital (per year)

Before electrification	After electrification
31	29

Source: Field Survey, 2014.

4.3 SHPs and Education

4.3.1 Literacy Rate of Study Area by Sex

Before electrification there were very limited opportunities to get literate for those who had to been engaged in household work. Electrification has shortened the duration of household work by the use of electric appliances on cooking and this has helped in saving time. It also has granted more study hours by the use of light.

The value of education is very important as it builds self- confidence and enhances people's ability and efficiency. It is difficult to accelerate development without good educational foundation. In Nepal, literate are those who can read and write.

Table 5.3.1(a)

Literacy rate of the study area by sex

Educational level	Male	Percentage	Female	Percentage
Illiterate	13	12.03	21	16.67
Secondary	54	50.00	61	48.41
Higher Secondary	28	25.92	37	5.56
Bachelor & Above	13	12.05	7	5.56
Total	108	100	126	100

Source: Field Survey, 2014.

The literacy rate is slightly different in male and female. The table shows the literacy rate in the study area. The literacy rate of male is 87.97% whereas that of female 83.33%.

Table5 .3.1(b)

Literacy rate of the study area before and after electrification

Educational level	Before electrification	After electrification
Illiterate	45	34
Secondary	119	115
Higher secondary	62	65
Bachelor & above	17	20
Total	234	234

Source: Field Survey, 2014.

The table 5.3.1(b) shows the number of illiterate to be decreased from 45 to 34 which shows the literacy to have increased after electrification .The literacy rate also is found to increase from 84.61% before electrification to 85.65% after electrification.

4.3.2 Drop Out Ratio and Study Hours

Electrification has brought a decrement in the dropout ratio. It has brought an increment in children enrollment in school as the people more after listen to radio and watch television which help them to get conscious about the importance of education,which is possible due to electricity. In the study area children of 15 HHs were found to have dropped out before electrification whereas after electrification it was found that only children of 7 HH dropped out.

Table 4.3.2

Impact on Dropout Ratio

No. of household member dropout	
Before Electrification	After Electrification
15	7

Source: Field Survey, 2014.

4.3.3 Change in Study Hours

It is obvious that electrification brings access to light which helps in the increment in study hours. The early morning and late evening hours can be utilized for studying. The data shows that electrification has brought positive impact on study time duration

Table 4.3.3

Change in study hours in Average (per day)

Increase in study hours	Numbers of students
Upto 1 hours	40
1 to 2 hours	30
2 Hours and above	8
Total	78

Source: Field Survey, 2014.

Out of the 78 students of the surveyed household, 40 had their study hours increased by 1 hour, 30 of them had their study hour increased by 1 to 2 hours and 8 of them had their study hour increased above 2 hours on daily basis.

4.3.4 Impact of Electrification on Performance of School

Electrification has brought a positive impact on the performance of student on school. It is due to the increase in study hours as well as use of modern technologies in teachings. The table below shows the more in the performance of students after electrification.

Table: 4.3.4

Impact of on performance of school

Percentage	Number of students	Percentage of students
Upto 5%	30	37.5
5% to 10%	25	31.25
10% to 15%	18	22.5
15% to above	7	9.75
Total	80	100

Source: Field Survey, 2014.

The above table shows that 37.5% of the student have increase their marks by 5% 31.25% of student increased their marks by 5% to 10%, 22.5% of students increased their marks by 10% to 15% and 8.75% of total surveyed student increased their marks by 15% and above.

4.3.5 Impact on the Use of Modern Appliances in Teaching

As the modern equipment are electricity bound, electrification has brought an increment in use of model electrical appliances overall. In teaching too, there is a significant rise in the usage of it. The table below shows the increment on the use of electrical appliances in teaching.

Table 4.3.5

Change in the use of modern appliances teaching

Appliances	B.E.	A.E
Projector (days per year)	0	15
Laptop (Number in school)	1	12
Cd Players (Numbers in school)	3	13

Source: Field Survey, 2014.

The table 4.3.5 shows that the number of days for the use of the projector to 15 days per year after electrification. The use in the number of laptops after electrification increased from 1 to 12 and the use of CD players has increased to 13 from 3 after electrification.

4.4 SHP and Sustainability

Sustainability simply means the ability of a project to maintain its project operations, targeted services and benefits during its projected life time. Almost every dimensions of sustainability analysis revolves around the local condition, O & M cost, economic benefit and environmental impact assessment. Despite adequate availability of surface water, several water resources projects have not been yielding expected output. The following section will present the analysis of the factors and of the elements in detail.

4.4.1 Allocation of Benefits

The project is found to be beneficial to most of the local in the sense that the electricity generated has been used for lighting purpose. It has also contributed in employment generation, improving environmental sanitation, irrigation and so on which is shows in the table below.

Table: 4.4.1

Allocation of benefits in sampled household

S.N.	Impact	No. of HHS	Percentage
1	Employment Generation	14	31.11
2	Improvement in Environmental solution	10	22.22
3	Irrigation	13	28.88
4	Others	8	17.79
Total		45	100

Source: Field Survey, 2014.

From the table, it has been found that more than 31 percentage of the sampled household are found to be involved in employment, about 28.88 percentage of HH beneficiary of irrigation and there were 22.22 percentage who got beneficial from environmental sanitation.

4.4.2 Local Participation

The sustainability of the project is also influenced by the participation of local people. During the study, it was found that participation of local people in different aspect was found to be as follows.

Table: 4.4.2

Participation of sampled HHs

S.N.	Involvement	No. of HH
1	Ownership	15
2	Management	2
3	Employment	8
4	No. Participation	20
Total		45

Source: Field Survey, 2014.

The table depicts that 15 HHs were owners of shares of the project, 2 HH were indulged M management, 8 HHs were employed on the project whereas 20 HH were found be not involved in any aspect on the project.

4.4.3 Capacity Building

In the study area it is found that the project has been providing training facilities to the locals. The training provided has been beneficial to the locals and the for the projects sustainability itself. It has been providing general as well as work specific training facilities. During the survey it was found that it HHs were provided with general training, 23 HHs were provided with work specific training whereas the remaining 5 were not involved in any training.

Table 4.4.3

Training provided to Sampled Household

S.N.	Type of Training	No. of HHs
1	General	17
2	Work specific	23
3	No. Training	5
	Total	45

Source: Field Survey, 2014.

4.4.4 Spare Parts and Maintenance

During the study it was found that these was a proper body that was responsible for making available the necessary parts. The spare parts are easily available as the project is within 64 km from the city Butwal. The project owners are mainly responsible for the

maintenance of the project as it is based on private ownership model with certain percentage of shares provided to the local community.

4.4.5 Use of Electricity

In the study area in it is found that the electricity is generally used for productive purpose. The main use of electricity was for lighting. The table below shows the use of electricity for different purpose.

Table 4.4.5

Use of Electricity

S.N.	Purpose of use	Percentage
1	Lighting	89
2	Manufacturing	5
3	Irrigation	3
4	Others	3
Total		100%

Source: Field Survey, 2014.

The study several that out of the total electricity produced 89 percentage is used for lighting, 5 percent for manufacturing, 3 percentage for irrigation and remaining 3 percentage for other purpose.

4.4.6 Effect of Sedimentation and Flow Water

As the project is developed on flowing water model there is a negligible impact of sedimentation in the production of electricity. During the study it was found that project has not been affected by sedimentation. The study also shows that there is very minimal variation in flow of water as the supply of electricity thought-out is year is same.

The study also reveals the following facts:

1. There is a balance between demand and supply as the study area is load shedding free zone.
2. Monitoring and evaluation of the operations in the project is done by the locals, management of the project and on the government level too.

CHAPTER – V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Major Findings

Hydro- electricity is one of the most eco-friendly form of energy that is beneficial for social, as well as economic development. It has varied use from cooking to running factories. Hydropower is one of the factors for bringing changes in the education level and health and this has played a significant role in improving the livelihood of the rural community.

Nepal is one of the poorest countries in this world. Approximately, 21% of the total population is living below the poverty line. Most of the poor in Nepal are peasant farmers and have been living in the rural part of the country. To reduce this poverty and to strength the living standard of the poor, hydropower projects can play a significant role which can supply reliable and sustainable energy for the development of education and health status.

Aadhikhola hydropower project, 5.1 MW installation capacity located in western development region is found to be more attractive for sustainable development of Syangja district. It is a eco-friendly project that has won" Blue Planet Award". It has been used for the electrification of most part of Syangja district. Our study has mapped various positive impact on health and education. The study has presented related to sustainability.

The major findings can be summarized as follows:

The sex ratio of the study area is 85.71. The number of people suffering from different disease is found to be decreased from 64 to 41. Also, the health expenditure has risen to Rs 7933 from Rs 5733. The number of visits to health institutions have increased on an average.

The literacy rate of male is 87.79% whereas that of female is 83.33%. Also, the literacy rate has risen from 84.61% to 85.65% after electrification. The dropout ratio has decreased from 15 to 7 whereas the study hours have increased. The use of electrical devices has increased in teaching.

The project has been beneficial to the local people, 31.11% of the sampled household have benefited from employment, 28.88% from irrigation 22.22% from the improvement in environmental sanitation. The local participation is ensured as 15 of the sampled household are indulged in ownership. Out of the total electricity produced 89% is used for luminance. The effect of sedimentation is found to be minimal.

5.2 Conclusion

Nepal has vast hydro-resources which represents a source of potential wealth. Commercially viable hydropower generating potential is estimated to be 83,000 MW. Hydro-electricity is the engine of growth and development of Nepal and economic activities cannot get accelerated without electric fuel. It is the back bone of development and essential for industrialization, agricultural development, transportation and other sectors. Nepal has its abundant hydropower potential but its limited unscientific supply of energy is often a major constraint in the development of the country's economy.

The primary challenge encountered by Nepal for hydropower development in the twenty first century is how to supply reliable, affordable and cheaper electricity to the domestic population. Rural electrification is essential for the economic prosperity and advancement. The access to electricity is to be taken as the key indicator to the progress of living standard. It enhances the capacities of the people to reduce the poverty. Nepal is currently facing an acute power shortage, which has negative impact in economic growth.

Andhikhola hydro projects are specifically installed for the electrification at the local level as it has not been connected to the national grid. Electrification in this district has been a continuous process as most of the VDC's are now electrified by the power provided by this project. The project is going through the process of up gradation in it power generation capacity. Our study has revealed various positive impact electrification has bought on education and health. It has mapped out the problems regarding sustainability of the project and the necessary measures to solve it which can be concluded as follows:

The project has been helpful for the upliftment of literacy rate of local people of the study are this been contributing in increasing the literacy sate. Dropout ratio of local

children has decreased and study hours has increased because of electrification. The literacy level of women and positive way for the achievement of millennium development goal in education.

Electrification of the study area has brought improvement of health of individuals. The number of people affected with disease that has relation with electricity was found to be decreased. The frequency of visit to hospital has increased which shows an increase in the number of health institution and increase in medical facilities at local level. The number of days spent on hospital has increased because of which identification of disease and expenditure on health of each household has increased.

Sustainability of hydropower projects has always been a major issue. The project has been accepted by the local villages. The ownership model is such that the responsibility is with BPC. There is an arrangement for the technical support the study levels that for operation and maintenance of the project technical expert is required at the regional level. Good institutional arrangement, as well as the participation of stakeholders every aspect can be fruitful.

5.3 Recommendations

Rural electrification has been helpful in improving the health and education status to some intent in the rural part of the country. The development efforts needs to be reviewed and more projects based on alternative source of energy should be implemented.

Appropriate policies on community participation, management and ownership model, human resources capacity development and integration with other development project needs to be developed for the sustainability of the projects. The quality of installation of the project, productive use of electricity as well as reliable monitoring and follow of plan should be taken into account. The SHP deserves high priority in view of its role in overall socio-economic development of Nepal. Hence, the specific recommendations are as follows.

1. Alternative energy source should be made available for the improvement of health and education status of rural people.
2. Government should emphasize the development of infrastructures in remote, hilly and mountainous district, which support the development of hydropower.
3. Community participant should be ensured in all stage of development.
4. Identification, preparation and implementations of policies for capacity building should be done at regional level.
5. Good institutional arrangement as well as managerial capacity planning need to be adopted.
6. Prevention and control of sedimentation, hiring and training local worker for project work should be developed for sustainable development of hydropower in the rural part of the country.
7. An integrative approach to promote micro-hydropower development need to be adopted.
8. Community owned and managed hydropower plants should be promoted.
9. Technical training is necessary in both public and private sector particularly at the operative level to ensure sustainability of the projects.

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Appendix

Questionnaire 1: Household Information

Q.N.	Questions	Code/Answers
1.1	Name of the village	
1.2	Ward No.	1,2,3,4,5,6,7
1.3	Name of Household Head	
1.4	Gender	1. Male 2. Female
1.5	Age of Respondent	
1.6	Education	
1.7	Relationship of Respondent with Household	

Questionnaire 2: SHP and Health

Q.N.	**Questions**	**Code/Answers**		**Skip**
2.1	What kinds of effects are seen in health condition of family members after electrification?	a. Improved b. Same c. Worsened		
2.2	How many times did you visit the health institutions due to illness? (Write 'o' if no visit is made)	B.E.	A.E.	
2.3	How much time did you spend in health institution to cure diseases?			
2.4	How much money was spent to cure the disease? (Write amount in words)	1. Male 2. Female		

2.5	What kind of effects are seen in health condition of family members after celebration		B.E.	A.E.	
		a. Running nose b. ENT irritation c. Sinusitis d. Asthma e. Bronchitis f. Pneumonia g. Other specific diseases			

Q.N.	**Questions**	**Code/Answers**	**Skip**
3.1	Has electrification brought positive impact on education?	a. Yes b. No	
3.2	Has your children's study have increased after electrification?	a. Yes b. No	
3.3	How much hours of study has increased?	a. Up to 1 hour b. 1 to 2 hours c. 2 hours and above	
3.4	Has their performance in school increased?	a)Yes b)No	If yes go Q.N. 3.4.1
3.4.1	By how much percentage has the marks increased?	a. Up to 5% b. 5% to 10% c. 10% to 15% d. 15 and above	
3.5	Has electrification brought an increase in	a. Yes b. No	If yes go to Q.N. 3.5.1

	the use of modern electric appliance in teaching?		
3.5.1	Which modern appliances are used?		

Q.N.	**Questions**	**Code/Answers**	**Skip**
4.1	Has the project beneficial to the locals?	a. Yes b. No	If no, go to Q.N. 4.2
4.1.1	How has the project been beneficial?	a. Employment generation b. Environment sanitation c. Irrigation d. Other specify	
4.2	How has the project ensured local participation?	a. Yes b. No	If no, go to Q.N. 4.3
4.2.1	How has it ensured local participation?	a. Ownership b. Management c. Employment	
4.3	is there any training facility provided to the local community to increase resource capacity?	a. Yes b. No	If no. go to Q.N. 4.4
4.3.1	Which kind of training has it been providing to impose human resource capacity?	a. General b. Work specific	

4.4	Does the project have easy access to spare parts?	a. Yes b. No	
4.5	Which body is responsible for the maintenance of the project?	a. Local b. Project owner c. government	
4.6	Has the electricity produced been used for productive purpose?	a. Yes b. No	If no, go to Q.N. 4.6.1
4.6.1	If so, mention the purpose.	a. Lightening b. Manufacturing c. Irrigation	
4.7.1	What is the effect of sedimentation in the sustainability of the project?		
4.8	Is there balanced between demand and supply?	a. Yes b. No	
4.9	Which authority is responsible for monitoring and evaluation?		
4.10	Is there any variation in the flow of water?	a. Negligible b. Moderate c. Significant	

Virtue: the quality of doing what is right and avoiding what is wrong.