CHAPTER-ONE

INTRODUCTION

1.1 Background of The Study

Nepal is a small landlocked country situated in the central Himalaya with sharp contrast in elevation with an area of 1,47,181 square kilometers whose length is 885 kilometers from East to West and distance between Northern and Southern border is 193 kilometers, and total population is about 23.4 million. It is a mountainous country situated at latitude 26 22' to 30 27' North, longitude 80 4' to 88 12'East. Along the southern border the country is flat and at sea level. This fertile area, 30 kilometer in width, is called Terai. The area north of it is called hills, with an altitude between 1000 to 5000 meters, while along the Northern border the highest mountain in the world, with peak over 8848 meters are found. Most of the land surface in the hills and mountains are steep to very steep while the land at the Terai is gently undulating with a slope of less than 1percent. Therefore, most of the country land is higher mountain and rolling hills accounting for about 83 percent of the total land area while the 17 percent is occupied by the plain Terai. It is located in between two big countries, China to the North and India to the East, West and South. So, it is called Sandwiched.

It is landlocked from outside and another mountain locked from within. This landlocked situation seriously limits the capacity of Nepal to pursue economic development. Communication and transportation are the most basic infrastructure which are necessary for the development of Nepal, is a formidable task in mountains and Hills Nepal.

Nepal remains as one of the least developed country in the world. Out of total population of this country, about 85% live in rural areas. About 31% people of the country live below the poverty line. At the same time, the human development index (HDI) is also embarrassingly low (0.527) in comparison to other South Asia countries and the world. According to the census 2001, crude birth rate is 33.1 (in per 100 population), crude death rate is 9.6 (in per 100 population), infant mortality rate is 91.2 (in per 1000 live birth) and life expectancy is 59.7. Energy situation in Nepal is with 15 GJ per capita energy consumption like many under developed countries.

The government is faced with a dilemma of low economic growth and wide spread poverty in the country. The government directly effects towards accelerating economic growth as well as alleviating poverty. Therefore, the rural sector needs modernization, diversification and list system. A properly designed and effectively implemented financial system could help the poor rural people to create productive assets as well as increase employment and income.

Energy is one of the vital inputs to livelihood and consistent availability of affordable energy sources of the prerequisites of socio-economic development of Nepal. Although Nepal possesses enormous potential for hydropower generation, only 17 percent of the households of Nepal have access to electricity. But population census of 2001 shows the total population to have access to electricity is 40 percent. Access to electricity in rural areas where only 5 percent of the people have electricity facilities is still lower. It is estimated that more than 85 percent people live the rural area. It is estimated that Nepal has 42,000 MW of economically feasible hydroelectricity generation capacity out of the potential of 83,000 MW. It has been able to produce only the fraction of it. Still almost 90 percent of the energy needs in Nepal are met through biomass such as fuel wood, agriculture residues, animal dung etc.

The remoteness of many hill settlements of Nepal makes these areas inaccessible from electricity grid and therefore lower access to electricity facilities. In a country with our kind of terrain, providing some of the basic necessities are close to impossible, because of the inadequate infrastructure, scattered rural households, extremely high cost of centralized national grid power supply and poor purchasing power of the people. Practically, each and every aspect of human life is associated with supply and consumption of energy item. However, the energy supply options assume the challenges from the point of view of social, economic and environmental costs, benefits and risk.

Nepal is facing enormous challenges in the path of Rural Development. One of the major infrastructures required for sustainable development of any nation is the power sector. Energy is essential not only for meeting necessities like cooking and lighting but is also vital for productive sectors of the economy like industries, agriculture, service etc. World energy consumption has been growing at the average rate of two percent per year for nearly two centuries. Similarly, growth is expected to continue in the future. It is likely that the current pattern of rising conventional energy consumption can not be sustained in the

future because of environmental consequence of heavy dependence on fossil fuels, in particular, because of global warming, urban pollution and acid rain. At present a near consensus appears to be emerging that renewable energy technologies need to be promoted of global energy supplies are to be placed on and environmentally sustainable path.

Energy source is Nepal can be broadly categorized into three groups such as traditional biomass energy, Commercial non-biomass energy and alternative energy. Traditional energy includes fuel wood, agricultural residue and animal waste. Commercial energy comprises electricity, petroleum products and coal. Alternative energy sources include biomass, geothermal, micro-hydropower, biogas, solar and wind energy. The energy consumption in Nepal is estimated at about 85.27 percent from traditional energy sources, 14.24 percent from commercial energy sources and only 0.48 percent renewable/other sources. About 40 percent of the total populations has benefited from electricity by the end of 9^{th} Five Year Plan. This 40 percent reported to include consumption of 33 percent from National grid and 7 percent from alternative energy. The rural population, which comprises about 85 percent of the total population, has very limited access to electricity. Alternative energy is the ideal answer to the present energy crisis of Nepal. Alternative energy technology (AETs) is a synonym for new, renewable, and non-conventional forms of energy. The most important alternative energy technologies in the context of Nepal are related to Micro-hydropower, biomass energy, solar energy, wind energy and geothermal energy. The use of AETs has been gradually increasing for the last two decades all over world. The main sources of these alternatives are Water, Sun, Air and Biomass energy.

Solar energy is renewable energy. Renewable energy is the terms used for forms of energy that can be regenerated, or renewed, in a relatively short amount of time. The flow of renewable solar energies on earth is essentially equal to the flow of energy due to solar radiation. Today solar sources provide around 10 percent of the energy used worldwide but in lessdeveloping countries their share is still of the order of 40 percent. (Pradhan & Pradhan, 2006)

Solar home system is a method to generate solar energy in the realm of electricity, water pumping, heating, communication etc. considered as the SHS have already been installed in different parts of country. (AEPC, Report 2006) The ESAP phase I had targeted to support for installation of 2500 SHS. AEPC/ESAP shorted providing subsidy for SHS through the interim rural energy fund (IREF) from April 2001. Up to date, the solar energy

programme of AEPC/ESAP at the end of ESAP I, about 69,533 SHS have been installed and subsidy approved by REF in about 1855 Village Development Committee of 73 districts (AEPC Report 2007).

Despite the substantial contribution that solar energy technology can provide to the country in meeting its energy needs, no definite plans and programmes have been formulated by the government for its development. Even the present 10^{th} five year plan, which envisages government effort in developing alternative and decentralized energy resources, has provided detailed policy and programmes including provision for an institutions involve in the supply of solar energy and its development activities. The main organizations in the country are Research Center for Applied Science and Technology (RECAST), Royal Nepal Academic of Science and Technology (RONAST), Center for Renewable Energy (CRE), Center for Rural Technology (CRT). Other organizations having limited involvement are Nepal Telecommunication Corporation (NTC), Nepal Solar Energy Society (NSES), Water and Energy Commission Secretarial (WECS), Solar Energy Light Fund (SELF) and certain INGOS.

1.2 Statement of the Research Problem

Due to population growth, the demand for energy is increasing day by day in the country. Major share of energy consumption is met through traditional source. The renewable energy sources are to be developed and solar energy promotion will be a significant one to struggle for improving this condition. Nepal is rich in water resources however lack of loan it can not be implemented as it is. Solar is rural based technology as well as subset of sustainable energy, many studies done on solar energy have drawn the positive impacts on women health and their socio-economic activities. This study would be important for investigating the changes in women's status and activities of solar users' household in the area under study.

The supply of energy is often a major constraining factor of rural development. Deficiency in energy can directly result in physical paralysis of a modern society. The working of today's way of life requires energy in different forms for different purpose. However most developing countries are facing energy-related problems as the cost of fossil fuels increasing and forest resources decrease. The energy consumption is the increasing function of the population growth and industrialization, which means that either affluent

nation have to reduce consumption or the reserve of the resources will decline ever faster than the estimated. This energy consumption growth rate (i.e. 3.2%) is greater than the population growth rate (i.e. 2.25%).

The imbalance between energy demand and sustainable resources management is already a serious one. In other hand commercial sources of energy are not available within the country. The country has to spend a huge amount of foreign exchange in importing this energy. Mini and micro-hydropower is more capital intensive, which is not suitable because this source is technically and economically complicated. However, the hill region of Nepal is particularly disadvantaged on the energy front lack of transport facilities in this region limits the scope or the use of several alternative energy sources. This region as also economically poor, hence the people cannot afford the use of commercial energy sources.

There are some problems for the development of SHS, such as lack of awareness, information and knowledge about the application and benefits of SHS among the people. Because of lack of standard for quality control and recommended code of practices of SHS, lack of subsidy as well as fiscal incentives to the users of SHS, poor monitoring and evaluation work, and lack of Research and Development inadequate for the rapid expansion and development of SHS. There is no direct government subsidy on the installation of SHS. One of the main constraints in the promotion of SHS technology is the high initial cost and there is a total absent of institutional coordination in the field of SHS development, dissemination and promotion in Nepal.

To meet the increasing demand in the consumption of energy for various purposes in Nepal and to ease the impact of the fuel crisis, the government must adopt a firm policy on utilization of various sources of renewable energy available in Nepal. As solar energy is available in abundance throughout the country and the recurring expenses of the devices are almost nil, the government must give priority to the utilization of this energy on a mass scale wherever this is possible. Solar energy is most appropriate technology to fulfill the demand of the rural hill areas. It is helps us live mere comfortable. Thus, it would be advantage for solar power energy development with rural development. Majority of people share energy consumption is met through traditional source like fuel wood, animal dung and agriculture wastages. In FY 2007/08, traditional biomass sources of energy share about 87.8 percent of total energy where as commercial and renewable sources of energy limited to 11.5 percent and 0.7 percent respectively (Economic Survey, 2008/09)

1.3 Objectives of The Study

The general objective of the study is impact assessment on the use of Solar Home System (SHS) in the Gwagha VDC of Gulmi District and its role in rural society. However the specific objectives of the current study are:

1. To identify the various uses of Solar Home System in the VDC.
2. To explore the socio-economic status of Solar Home System user community of rural area.
3. To provide, a basis of theoretical as well as practical concept and knowledge for further study and research on rural energy Solar Home System.

1.4 Rationale of The Study

More than 85% of the total population still lives in rural areas of Nepal. More than 3 million houses in these areas are deprived of electricity, a basic need in the 21st century. This is the reason why many people in remote areas of Nepal are still using kerosene lamps. Kerosene based wick lamps are the most common source of lighting in almost all the rural un-electrified areas of Nepal. Dry cells are used to power radios and torch lights. An effort has been made to replace the kerosene lamps with energy efficient, cost effective and reliable electric lamp. Similarly, SHS based torch lights with environmentally friendly batteries and battery less radios have been designed and developed to protect the environment from the hazards posed by discarded conventional batteries.

Nowadays developed SHS lights are being considered for small area lighting purpose because of their focused and high luminous intensity. Solar lights are being incorporated into specialized high reliability, low battery drain flashlights for emergency and other applications as well as into plug-in replacements for incandescent lamps. This system has been designed for technical feasibility, financial viability and acceptability by the Nepalese in the villages of Gwagha VDC of Gulmi district.

The remoteness of many hill settlements of Nepal makes these areas inaccessible from electricity grid and therefore lower access to electricity facilities. Although, many part of the Nepal lies on the good solar belt, a detailed radiation mapping is not available. On an average, there is more than 6.5 hours of sunshine per day in Nepal. As per the World

Meteorological Organization, the average isolation for Nepal lies between 4-5 KWh per square meter per day. So there is great possibility of development of large –scale solar PV home system in Nepal. In Nepal the important area of the solar energy use has been electricity from solar photovoltaic system. The global technological advancement in solar PV resulting in reduced cost of the solar panel, the solar potentiality of the country and the absence of the new and renewable sources of energy provide the very conducive environment for the promotion of solar energy in Nepal. Solar energy could make significant contribution in meeting the rural as well as urban energy needs for the decentralized rural electrification. In the remote rural areas, where there is no possibility of the extension of the electricity grid from the hydropower, only option for the rural electrification is the solar PV home system which contribute, in a small way, towards the control of migration of people from rural to urban areas in search of better way of life and other facilities, creation of job and opportunity of modern facilities in the rural areas.

Solar energy is less costly then micro hydropower and other electricity. It is easily can carry form one place to another place. The outcomes of the study would be of great importance to plan appropriately for further development of technology and it would be helpful to solve the problem of existing energy crisis scenario.

The study conducted at Gwagha VDC of Gulmi district, a typical rural settlements, has its own energy related problems. Though the VDC is connected with national grid electricity in few wards, but the people use the electricity only for lighting and some kind of entertainment purpose for some times, not daily, because they are suffering from national grid, due to irregular. Their primary fuel for the daily need is still fire wood, kerosene and dry cell (battery) for cooking and lighting. A detail research on the pattern of energy consumption not only provide the information factor affecting energy consumption, but also reflects environment related problems brought about by the energy use habits of the local people. This study would be fruitful to formulate the energy related programs and policies in the study area.

1.5 Limitation of the study

There are following limitations of the study:

- This present study is based on and limited to the solar home system users of Gwagha VDC of Gulmi district. Thus, generalization of the conclusion derived from the study in national level may not be valid.
- This study is very specific like that of case studies. Thus, study is only deals the problems, possibility and importance of solar home system in Gwagha VDC.
- This study is limited in terms of deeper analysis as only a few variables selected from the numerous factors affecting the solar energy consumption in the study area.
- This study is takes the socio-economic, health, communication as well as educational aspect.
- The analysis of data has based on simple statistical tools. As more complex and sophisticated tools has not adopted.

1.6 Organization of the Study

The study reports has been organized and presented in six different chapters. Chapter one is related with basic introductory information about the study and study objectives. Chapter two attempts to present finding from relevant literature review. Chapter three consists of the methodology of the study. Findings and discussion part of the study has been organized in chapter four. This chapter consists of mainly three thematic headings namely brief introduction of district and VDC, socio- economic characteristics and energy use condition. Similarly, chapter five reveals the socio-economic impacts by SHS with some benefits, problems, relation to rural development with SHS and respondent's expectation and suggestions. And chapter six gives conclusion of the study and presents recommendation based on the summary and conclusion.

CHAPTER – TWO

REVIEW OF LITERATURE

This chapter refers to the research and outcome of the related literature (about Solar Energy). Several books and publications were reviewed by the researcher while undertaking this research.

Study on the rural energy source like solar energy is a very important topic in the sense that, it required a wide range of literature during the work. Basically, study was carried out on the articles related to the solar energy. An extensive study was carried out in various publications and reports also, which provide various important information related to research work. In the context of the research and development of modern solar energy technology in Nepal is still in its fledgling stage, so there is no adequate study the impact assessment of solar home system in the rural areas. Perhaps certain government, non-government and private institutions carried out its some reports.

The World Energy Outlook (2000), presents the fact that some 1.6 billion people, one-quarter of the world population, have no access to electricity. In the absence of vigorous new polices, 1.4 billion people will lack electricity in 2030. Four out of five people without electricity live in rural areas of the world mainly in south Asia and Sub-Saharan Africa (IEA: 2002)

Eckholm in 'Losing Ground', underlines the urgent issues of global environmental stress and world food prospects. It takes into account the pollution problems of industrial world and ecological degradations like deforestation and soil erosion seriously damaging the land of developing countries. In this book, the author summarizes the energy scarcity in Nepal by quoting his conversation with a taxi driver in Kathmandu. This book, besides highlighting the energy problems; introduces the reader to environmental and resource problems in a global context.

"Escaping from the rural energy dilemma; a process of matching technologies to local needs and resources" a research paper not only highlights the main interlocking energy problems of the developing world, but also provides a five-step process for matching

decentralized energy systems with energy needs and local resources in rural areas. It also provides a step- by –step methodology for identifying and developing specific programs for local energy needs and resources. Thus this paper is useful guide for planners seeking solve energy problems of the developing countries (Ashworth et al, 1992).

Earl in "Forest Energy and Economic Development" states that the emergence and development of civilization has been closely associated with an increase in the per capita consumption of energy, for example, the use of tools and weapons, control of fire, farming of animals and cultivation of the soil. Although, animal, water and wind power helped in the evolution of man as a dominant species, there is a little doubt that the controlled use of fire was the fact that led to industrialization (Earl: 1995).

"Renewable energy in India: Business Opportunities" provides information of all the possible Renewable Energy areas that have scope for investment. It offers detailed information on the existing and potential strength of each program, the potential sites in the country, the achievements to date, specific investment opportunities and benefits that can be made. It also gives a glimpse of the policies and procedures under each Renewable Energy area and the contact agencies and persons (Winrock International: 2004).

Human Development Report 2004 has also included the energy consumption level of the different countries and regions. The report has cited the energy consumption data of high, medium and low human development countries. The report clearly shows that the energy consumption level of developed countries, OECD and Central and Eastern Europe is for higher that from Sub-Saharan, South Asian region and least developed countries.

Table 2.1

World Energy Use Trend

HDI/ Region	Traditional fuel consumption (% of total energy requirement)	Electricity consumption per capita (KW/h)		GDP per unit of energy use	
High Human development	2001	1980	2001	1980	2001
	4.5	5700	8520	3.6	4.7
Medium Human development	13.4	387	1022	2.6	3.7
LowHumanDevelopment	75.8	157	218	2.4	2.2
Arab states	5.9	626	1783	5.1	3.4
East Asia and Pacific	10.9	329	1194	1.9	4.2
Latin America and Carebian	21.4	1019	1888	5.7	5.7
South Asia	23.4	171	554	3.5	4.3
Sub-Saharan Africa	62.6	434	495	3.0	2.4
Central and Eastern Europe and CRS	4.0	3284	3326	-	2.0
OECD	4.5	5761	8503	3.6	4.7
High income OECD	4.1	6698	10105	3.5	4.7
World	10.7	1573	2361	3.2	4.2
Nepal	88.0	17	63	2.4	3.5

Source: Human Development Report, 2004

Energy Synopsis Report (1994/95), published by Water and Energy Commission Secretariat (WECS), gives the complete picture of the national energy situation. Besides explaining the Govt's planning initiatives including models and policy development, the report also contain present issues and constraints concerning the energy sector of Nepal.

Rijal (1998) in 'Energy use in Mountain Areas' has stated four pronged strategy for sustainable energy development in the mountain. He also describes the various policies and institutional measures that need to be taken to that sustainable development of the energy sectors in Hindu Kush Himalayan Region can become a feasible proposition.

Sharma (1998) argues that fundamental issue on energy is the imbalance between the energy resource endowment and its' consumption. Nepal's energy requirements are being

met by forests, which are depleting at a highly unsustainable rate while hydropower, which has massive potential, has remained unexploited. He has further presented the energy consumption pattern among rich and poor people and capital require to consume the energy needs form their total income. According to Sharma, on average a consumer uses about 125KCE energy per year out of these electricity accounts 15%, kerosene accounts for 28%, and fuel wood accounts for 57%. A rich person consumes 132 KEC per year. 27% is accounted for by electricity, 40% kerosene and 33% by fuel wood. In contrast, electricity accounts for 12%, kerosene for 23% and fuel wood 65% out of the 83.5 KEC energy consumed by the poor. The consumption of energy required and average consumer to spend about 10.6% of their income on energy while the rich spend about 7% of their income for the same.

Rural Household Energy Use in the Tarai and Mid Western Hill Regions of Nepal' a research report of WECS provides the information on energy on situation in this area. This report has mentioned the energy and use pattern, energy resources, energy consumption by fuel and region wise etc. according to this report, rural households in the Tarai consume on average 17/218 MJ of energy on the per capita basis in a year. The per capita consumption of individual energy sources in the total are 596 kg of firewood (58%), 80 kg of twigs (71%), 194kg of agricultural residue (14%), 38kg of other plant based material (2%) and 8.2 liters of kerosene (2%).

Similarly, "Energy Resource and Consumption Profile of Mid Western Development Region of Nepal" (1995) a research conducted by WECS flashes the energy resources, consumption pattern by area (rural, urban) and ecological region, fuel type, etc. in Mid-western Development Region. According to this research report, energy consumption by end-use and fuel type in 1993/94 is as follows.

Table 2.2

Energy Consumption by End-uses, MWDR, 1993/94

End uses	Urban	rural	MWDR
Lighting	4.4	2.1	2.2
Cooking	83.1	72.1	72.5
Water heating	1.3	0.2	0.2
Animal feeding	2.6	18.1	17.5
Space heating/cooling	7.7	6.4	6.4
Agro processing	0.2	0.5	0.5
Appliances	0.1	0.0	0,0
Rituals	0.5	0.6	0.6
Total	100	100	100.0

Source: WECS, 1995

'Rural Energy: Reaching the Rural Poor, provides information on all the activities and achievement made by the Rural Energy Development Programme (REDP) Nepal for the promotion of energy and related technologies in remote rural area where national grid of electricity can not be reached near future. The report further states that out of the total power of 1312.5 KW generated by the REDP supported 101 miters micro-hydro system so far, 201 KW (15.16%) was produced in 2002. Similar achievements were made in other rural energy technologies; 318 solar home systems (21% of the total 1538), 1373 toilet attached biogas plants (53% of the total 2609) and 1024 improved cooking stoves (16% of the total 6652). Furthermore, the programme has continued to support for the development and strengthening of successful initiatives in the areas of organization development, capacity building, environment research and development, and woman empowerment at the local levels (REDP: 2003).

NEA, Annual Report 1999/2000 shows that, Nepal with a per- capita energy consumption of about 15 GJ is one of the five least energy consuming countries in the world despite the fact that there is 2.27 percent of the total hydropower potential in the world. The preponderance of a rural sector characterized by a subsistence economy and low economic growth largely explains the low level of energy consumption. Evidence reveals a close association between economic development and per capita energy consumption. Despite this low level of per capita energy consumption, the prevailing pattern of energy use and

production indicate many elements of unsustainability (Banskota and Sharma, 1997). The energy problem in Nepal arises not from excessive reliance on non renewable energy resources, but rather from the fact that one form of energy (fuel wood) is being consumed at an unsustainable rate, while the vast potential of other forms of renewable energy remains virtually unused (ICIMOD, 1999).

WECS (2006), the overall energy consumption of Nepal is largely dominated by the use of traditional non commercial forms of energy such as furl wood, agricultural residues and animal waste. But this share is in the decreasing trend. The share of traditional forms of energy to the energy consumption is estimated to about 88 percent in 2004/05 as compared to 91 percent in 1995. The remaining 12 percent of energy consumed is through commercial source (petroleum fuels, coal etc.) and renewable. It shows that though in the slow pace, there is a shift in the energy consumption pattern from traditional to the commercial and renewable sources. The share of commercial has increased from about 9 percent in 1995 to about 12 percent in 2005. Similarly there is a growing trend in the renewable. Within the commercial source, electricity is in the higher side in substituting other fuels.

In the global context, the study of international per capita energy consumption exhibits an interesting picture. It clearly shows the classification of developed and developing countries on the basis of per capita energy consumption levels. Countries such as United State, Australia, New Zealand, Singapore and Japan etc. are at par or equal to commercial and total per capita energy consumption whereas in the countries belonging to SAARC or some ASEAN regions, the scenario is quite different, having the wider gaps. The situation of Nepal also is not so encouraging because there is wide magnitude of 1: 14 between commercial and total per capita energy consumption. No matter at the global context but also among SAARC countries. Nepal's status of commercial per capita energy consumption level is at the button line i.e. 1 GJ.

WECS, Report (1994) has analyzed, the main feature of the energy section in Nepal is the growing imbalance between energy resource endowment and its current use. Heavily reliance o the dwindling 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 furl wood supply (6.6 million tones) 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 Tarai and middle mountains, home to 85 percent of the population.

Economic Survey Report under the Ministry of Finance portrays, per capita energy consumption may not signify the enhance betterment of the society. On the other hand it may lead to adverse impacts on agricultural productivity due to direct use of animal dung and agricultural wastes for fuel purpose. Further more it may also indicate depletion of forest because of forest because of dominance of fire wood in the energy consumption is taken as more appropriate variable for analysis. In Nepal, the per capita commercial energy consumption is 1.35 GJ in 1995/96 against 0.70 GJ in 1984/85. This is a change of 92.86 percent over the period of about on decade. However there are some variations in between. The main reasons behind increasing energy consumption level may be growth of automobile and oil consuming industrial establishment.

WECS (1995) Report, had been carried out at alternative energy is now accorded a greater significance than in the past. As such, if promoted and implemented properly, alternative energy technology has the potential to meet the major portion of the commercial energy demand from rural areas. Hence, it is becoming increasingly important to develop and promote sustainable alternative energy in Nepal wherever possible and where the supply of energy to the inaccessible parts of the country through and integrated national network is less cost-effective and more time consuming.

ICIMOD 1999, Report pointed that, in the past, the implementation of alternative energy technologies has not been very encouraging. Despite their 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 co-coordinating bodies), financial issues (high initial investment), technical issues (weak infrastructure), and managerial issues (lack of marketing skills).

Amatya (1997), study focused that the most striking issue is the gap in coordination and inter-organizational communication between the agencies dealing with the planning and implementation of alternative energy in Nepal. Due to the lack of such coordination, most

of the problems which require inter-institutional coordination has remained unattended have adversely affected the production and promotion of AET devices which are already proven under Nepal's socio-economic setup. Probably, a lack of confidence in alternative energy and awareness regarding its potential at the decision making level is one of the reasons which prevented formation of such an institution. It is evident that adequate monitoring and evaluation by appropriate institutions and continuous support from the government and non-government sector will prove to be vital in the successful implementation of these programmes.

NEA, Annual Report (1999/2000) shows that, a large part of the rural population consuming low electrical energy, there is no viable alternative to solar electricity for rural electrification. The operation and maintenance cost of diesel generators is too high, biogas technology does not work satisfactorily on the fairly cold high plains or in the mountains and would be difficult to realize with roving herds of cattle. Small hydro turbines need specific topographic conditions that are only found near a small percentage of users' dwellings. Solar electricity generating system which do not need furl or extensive infrastructure, are easy and quick to install and are thus the single most attractive alternative in many location of the country.

Shrestha, (2000), stated that, it is not claimed that solar electricity (solar home electric lighting systems) can solve rural electrification issues completely. The solar home system too has limitations and problems but these can be overcome with proper planning. There are six basic preconditions to be met if rural electrification problems are to be solved with the solar home electric lighting system:

- Proper SHS planning
- Sufficient and stable solar irradiance over the whole year.
- Low energy need of potential users.
- No electric grid connection in the foreseeable future.
- Proper maintenance schedule, and
- Active participation of the SHS users.

SHS will not meet demands where users already have or aspire to having consumer items such as refrigerators, deep freezers and washing machines, that is, relatively high-energy

consuming devices. SHSs are basically meant to supply direct current for such things as fluorescent tubes with electronic ballast, Television sets, radio and cassette or video players.

No specific strategies have been charted out for the development of solar PV system in the country. Capability to manufacture such equipment has not received adequate motivation in the private sector and no impetus seems to be forthcoming from the public sector. There is no direct government subsidy on the installation of solar energy system as is in other forms of alternative energy. However, industries manufacturing solar PV systems are entitled to seven years tax-holiday period; including two additional years for energy related manufacturing. The government also provides concessionary duties and tax on the import of raw materials and equipment to the solar power manufacturing sector (WECS, 1994/95).

Individual PV systems being used at the household level for domestic lighting and operating a few domestic appliances such as the ones installed in Pulimarang have shown good performance, except for some minor technical problems related with the battery, spare parts and overcharge protection systems (CRE, 1999). Solar electricity could be affordable for many purposes other than the domestic lighting and communication system in remote areas. Thus, with the decreasing cost of PV will play a much more important role in the future. Moreover, if higher up-front cost and system reliability aspects are tackled effectively, there is no doubt that solar energy will prove to be in the long-run an effective means of providing environmentally benign and clean energy. This will also ensure a sustainable future (Amatya, 1998).

According to a socio-economic impact study, the rural electrification schemes through PV systems have reduced the consumption of kerosene from 35 to 10 liters per households per month. Furthermore, they have reduced the consumption of dry cell batteries which have been the main source of energy for powering radios (CRE, 2006). There seems to be a services lack of government interest regarding the developing of solar energy in Nepal both in terms of policy planning as well as implementation.

2.2 Renewable Energy Development Scenario in Nepal

There is a dire need to substitute as well as supplement the traditional energy supply system by modern forms of sustainable energy in terms of resource and technology, because of the country's dependence on imported fossil fuel, high cost of grid connection and low and scattered population density, a decentralized energy supply system becomes the natural and feasible choice. Decentralized new and renewable energy systems such as micro-hydro, solar photovoltaic, biogas, improved cooking stove etc. provide feasible and environment friendly energy supply options in rural areas. The most important renewable energy technology in Nepal is related to Pico-hydropower and micro-hydropower (up to 100 KW), biomass energy (biogas, briquettes, gasifies, improved cooking stoves), solar photovoltaic (solar home system, solar PV water pumping, solar battery charging), solar thermal energy (solar water heater, solar dryer, solar cookers etc.

Renewable Source of Energy; Country paper of Nepal, has found that , Nepal has clear skies for about 300 days a year and the solar energy potential is fairly high. The average solar radiation varies with the geographical location of the area itself. In the mountains areas, it varies between 511 to 328.1y/day with maximum around April and minimum around December. Similarly, the maximum and the minimum values range between 57 to 314 1y/day in the hills areas and 537 to 309 1y/day in the Tarai. The monthly average for the Mountain, Hills and Tarai areas are found to be 415, 388 and 430 1y/day respectively.

NPC (2007), though the rural sector occupies a significant position in Nepal's economic development, the outcomes of development plans of last four-and –half decades regarding the rural development is less than expected. Shortage in the power supply, among others, can be taken as one of the major causes. Only seven percentages of the total people living in the rural areas are current using electricity services generated from sources of alternative energy.

While looking into the power production capacity of micro hydel of the country, adequate electricity can be produced from small streams in 55 districts; 4-5 KW-hr per square meter per day (8GW hr/day) electrical energy was produced from the solar power. Similarly, it is estimated that there is capacity of establishing 1.3 million biogas plants and it is also estimated that 11MW electricity was produced from the by-products of eight sugar factories of the country. Likewise, it is estimated that 3.1 million tones of oil was produced

annually from seeds of 160 types of plants found in the country. Since 10-13 percent of energy was acquired from the existing supply of firewood.

Table 2.3

Renewable Energy Database for Nepal

SN	Particulars	Description
1	No. of Rivers	More than 6000 with about total length of 45, 000 km
2	Theoretical potential of hydropower	83,000 MW
3	Commercial potential of hydropower	42,000 MW
4	Hydropower so for generated	600 MW (1.4% of commercial potential)
5	Average sunshine hour/day	8.6 with intensity of solar insolation of about 4.5 kwh/m2/day
6	Total energy consumption	8.6 million TOE; about 14.6 GJ per capita per year
7	Share of energy supply	
	Biomass	86%
	Petroleum	9%
	Coal	2%
	Electricity	2%
	Renewable	1%
8	Share of energy consumption	
	Residential	90%
	Industrial	4%
	Transport	4%
	Commercial	1%
	Agricultural	1%
9	Population coverage by electricity supply	
	Central Grid	33%
	Alternative energy	7%

Source: WECS, 2007

2.4 Renewable Energy Technology (installation up to mid 2007)

SN	Particulars	Description
1	Biomass based technologies	
	Improved cook stove	206,000 including national ICS programme and other programmes.
	Biogas plant installation	172,505 units
	Bee Hive Briquette Production (micro enterprise)	50 units
2	Solar based technologies	
	Solar PV installation for public utilities (aviation, telecommunication, health post etc)	44 units
	Solar Home System	82,674 units
	For water pumping system	40 units
	Solar cookers (parabolic type)	800 units (up to end of 2004)
	Solar dryer (Box and Cabinet type)	500 units (up to end of 2004)
	Solar water heaters (commercial)	35,000 units
3	Hydro based technologies (Decentral)	
	Micro-hydro system (3 to 100KW)	553 units with about 7805 KW power
	Pico-hydro system (up to 3 KW)	1124 units with about 2019 KW power
	Improved water mills	2719 units (288 long shaft and 2431 short shaft) under IWM support programme since Jan 2003 to July 2007 and around 1000 before that.
4	Wind based technologies	
	Installation of wind turbine units	Below 10
	Installation of wind pump units	Below 10

Source: WECS, (2008)

2.3 History of Solar Energy in Nepal

The solar energy resource in Nepal is abundant, evenly distributed over the country and over the seasons. The average solar irradiance for Nepal is around 4.5 kwh/m2/day at optimum tilt (Adhikari, 1998). Solar PhotoVoltaic (PV) system which generates electricity out from energy of the solar radiation has emerged as a viable option to meet electric energy demand, especially in remote areas of Nepal.

Nepal being located in a favourable latitude receives ample solar radiation; and sees about three hundred sunshine days in a year. It receives a good amount of solar radiation for the most part of the year, which makes Nepal a favourable location for the development and applications of appropriate solar energy technologies. The huge potential is also shown in the data presented by WECS (1984). Since, there are more than 300 sunny days in Nepal with about 8hours of average sunshine, there is a potential to exploit solar energy for various low intensity energy applications.

The exact date of first use of solar PV in Nepal con not be ascertained but it is said that first PV module was used in 1963 in Bhadarpur Airport for navigational purpose (Shrestha,1998). Recorded use of solar PV power for domestic electrification started in 1992/93. Use of PV power for rural electrification started with the effort of the government of Nepal with financial support from the French government in four rural areas of Nepal such as Kodari, Tatopani, Simikot and Gamgadhi. But the outcome proved to be failure as it was not a household based solar electricity system and electricity was distributed from a central station based in the village and a number of unforeseen technical and community mobilization problems cropped up (REDP, 1997).

Solar Home System lighting based on PV technology gained momentum after the successful launching of Pulimarag Village district in late 1993 by Center for Renewable Energy (CRE) with the support from Solar Energy Light Fund (SELF), USA and Pulimarang Community Support. The whole specific system was conceived, developed and managed by CRE with special needs of Nepal and proved to be successful pilot project of CRE. During the 1st phase of the Pulimarang Project 46 SHS installations in households were done. The installations were completed in 1994 (CRE, 2006). For the first time, Agricultural Development Bank/Nepal (ADB/N). provided 50% subsidy to install 40 Solar Home Systems (SHS) at six VDCs in Kabhrepalanchok district in June 1996 (Kayastha, 2000). Subsequently, the government announced renewable energy subsidy policy in October 2000. The subsidy policy addresses, among other renewable energy technologies, the policy related to solar energy systems. Accordingly, subsidy will be provided to SHS of 10-120 Watt Peak (AEPC, 2000).

Another major sector where solar PV is extensively used in water supply. In Nepal, use of solar PV systems to lift water for drinking and irrigation purposes started in 1986/87. In order to tap the potential of using PV technology in irrigation systems and drinking water

supply schemes, the subsidy policy has made a provision of subsidizing 75% of the cost of the cost of solar pump of capacity up to 500 Wp. Shrestha J.N. (1998).

Solar PV system have also been used by a number of health posts, schools and monasteries in rural areas for lighting, operating vaccine refrigerators and computers since 1993/94. Various government and non-government programmes have been providing support to install such systems.

2.4 Periodic Plan for Solar Energy

Solar energy along with the other renewable energy has been addressed by periodic planning since the Seventh Plan (1985-90). The Eighth Plan (1992-97) incorporated separate policies on alternative energy. The Ninth Plan (1997-2002) recognized solar energy, among others, as a source of energy to fulfill the rural energy demand. The Tenth Plan (2002-07) has given emphasis to promote solar energy including other renewable energies in rural areas. It has set a target of producing 3.5MW electricity energy by installing 52,000 domestic and institutionalized solar electricity systems in 52 districts during the plan period. It has also set a target of installing 100 solar PV water pumping systems in 15 districts and 2,7 00 solar cooker/ dryer also installed. In addition to this, competent manpower was producing by giving training regarding the installation of the solar energy system, to carry out feasibility mapping of solar energy at several places and researches to reduce the cost of installation (NPC, 2002).

Status of Solar Energy in Nepal

Modern utilization of solar energy in Nepal is in three forms – Solar thermal energy for domestic water heating, Solar PV system for electricity generation for lighting, entertainment, communication, and water pumping and Solar Black Box for drying crops. Crop drying using solar black box has not been fully commercialized yet. Some solar cookers were also introduced in Nepal in eighties, but they could not succeed because people had to change socio-cultural practices with such devices. Utilization of solar energy using modern equipment began in the clearly seventies through the introduction of domestic solar water heaters. Solar photovoltaic (PV) is not a new technology to Nepal. Till now fourteen companies have been recognized by Alternative Energy Promotion Centre (AEPC) and involved in the installation of more than 27,000 units in about 57 districts of the country. These systems have been used for the household lighting, electrical

power to TV and Radio and lighting in the small-scale business for example shop, workshop, cottage industries etc. in Nepal the other uses of the solar energy are solar water heater, which is used mainly for the water heating in households as well as hospitals, schools, hotels and lodges. The solar water heater are produced and marketed commercially. Other uses of solar energy are solar dryers, which are used for drying agriculture products, and in some places of Nepal it is used for drying of herbs and vegetables, which contributed to generate the employment in the remote areas where there is no other income generating opportunities. Another use of the solar energy is in the field of cooking. This technology is being promoted in Nepal after government began to provide the subsidy through AEPC. Even though at the very beginning it was not accepted widely due to traditional eating and cooking habits and lack of information, it is now gaining popularity which contributed to save fuel wood and kerosene consumption in cooking. Which contributed to reduce health hazards from kitchen smoke for the women. Similarly, since the few years back, solar PV systems are being used in water pumping for drip irrigation and drinking water.

The abundance of solar radiation in most part of the world provide promising source of energy where other conventional methods are going to be either very expensive or possible only in the far distant future. In Nepal, about 83% of the populations still have to live their lives in darkness and poverty without much hope in the way the country has been governed in the last 40 years. Nepal's situation for an establishment of hydroelectric power grid is available only in 40% of the country (As per the population Census 2001 and 10^{th} Five Year Plan). Under these circumstances, PV technology would provide the answer as the second eye in terms of hydropower. So far 277 institutional SHS has generated 846.88 kWp and 27095 solar home systems have generated 1038.78 kWp.

It is estimated that 4636 kWp of PV power is being utilized in various part of Nepal for different purposes such as standalone SHS (71.8%), Nepal Telecom (21.6%), Nepal electricity Authority managed centralized rural electrification (2.1%), water supply system (2.0%) and other (1.0%). For sometime to come, standalone PV system and PV integrated systems for telecommunication services will continue to grow due to their specific advantages. Efficient and effective operation of PV systems depends upon their optimum sizing which, in turn, also depends on the climatic condition of the place where the PV systems are supposed to be installed.

CHAPTER-THREE

RESEARCH METHODOLOGY

3.1 Research Design

This study has adopted descripto-analytic research on the basis of exploratory research design.

This study has investigated the benefits of solar home system on rural sectors. The study has find out the trends of solar consumption, health condition improvement due to solar home system. Thus, the study is exploratory research.The descript research design was utilized to interpret and relate the qualitative information derived during the survey. Information difficult or impossible to measure quantitatively was described verbally.

The analytical research design was used to establish the precise relationship between different variables. Thus, the study is descriptive and exploratory.

3.2 Type/Nature of Data

Both primary and secondary data were used in this study to make the study more qualitative. Primary data were colleced from direct field survey with the help of structured and semi structured questionnaire. Similarly, the necessary secondary data were collection from different books, journals, previous research works, reports, acts articles, plans and policies, VCD and DDC profiles, other published and unpublished documents related to the subject and other many more organizations.

3.3 Universe and Sampling Procedure

The universe for the study is ward no. 1- 9 of Gwagha VDC having 524 households. In the study are, out of total households, 67 households has been benefited from solar energy. Out of solar home system users in this VDC, this study has been done on 53% (36) households through random sampling.

The energy consumption behaviour among different ethnic groups and social class are not similar. The electricity service has not sufficiently reached all over in the Gulmi District.

3.4 Techniques of Primary Data Collection

Relatively few publications were available in libraries, institutions, energy related offices and department which have linkage with this study. Therefore the information has been collected from secondary sources but it was not sufficient to fulfill the objectives of the study. For the collection of primary data following data collection techniques were adopted.

3.4.1 Households Survey

The name list of the household head was obtained from the VDC office and house-to-house survey was conducted. The questionnaire forms were filled up by the researcher herself interviewing with household heads. In the absence of the households head, another senior person presented at the home during the interviewing periods was taken as the respondent.

3.4.2 Observation

To explore energy related problems and prospects in the study area visual observation by the researcher was also conducted. General problems kitchen and study room environment and remedies were observed. Information concerning difficulties in generating energy, Solar Home System of each households selected in sampling were visited and observed. The data were collected while observing the households environment, solar home system wiring, condition of panel, battery, bulb, study room etc.

3.4.3 Key Informant Interview

As the solar home system is the best option to combat with clean energy access in rural Nepal, this study were conduct as an exploratory. To dig out its reality key informant interview were applied informed people within the sampling. The key informants are teacher, political leader, VDC chairman and businessman.

3.5 Tools of Primary Data Collection

For the collection of primary data following tools were undertaken.

3.5.1 Structured Questionnaire

A detailed structured questionnaire was prepared keeping in view the objectives of the study. The questionnaire not only encompassed energy consumption behaviour, like; lighting, cooking, space heating, agro processing, entertainment of the people but also general socio-economic; education, income source, caste/ethnicity , background of the people.

3.5.2 Check list

To find more relevant local energy (source of electricity) related problems unstructured questions were asked to the local elites such as; teacher, ex-VDC chairman, local businessman and political leader.

3.6 Data Analysis

The primary data supplied by each questionnaire was coded and transferred into the spread sheet and tabulated manually with the help of computer programme.. Simple statistical tool were used to analyze the data along with tables and figures as required. And descriptive method also used for qualitative data.

CHAPTER-FOUR

DATA PRESENTATION AND ANALYSIS

This chapter attempts to analyze the collection of data and information received from the structure as well as unstructured questionnaires, observation and informal discussion securing the objective of the study and derive the major findings of the study. First of all it includes the brief introduction of Gulmi district and Gwagha VDC with including social character, social services like health, sanitation, education and occupation of villager.

4.1 Study Area

4.1.1 Gulmi District

Gulmi, one of the hilly district of Lumbini zone, is located in Western Development Region of Nepal. It is situated on 27 55' N to 28 27' North latitude and 83 10' E to 83 35' East longitude. The area covered by Gulmi district around 1,149 square k.m. and it is approximately 40 km in length from East to West and 30 km in breath from North to South. This district is bounded by the Syangja and Parbat in East, Pyuthan in West, Palpa and Arghakhanchi in South and Baglung in North. The district consists of 79 VDCs. It is also divided into three election regions according to political point of view as well as thirteen Ilaka from the administrative and development point of view. The headquarter of Gulmi district is Tamghas VDC. The Gulmi district is situated between middle-hilly area and Mahabharat range. It's height 465 (Ridee) meter to 2690 (Thapleko lake) meter from the sea level. The area which is covered by forest is around 37.67% in the district. The main rivers and streams of this district are Badigad, Nisti, Ridee, Kaligandaki, Panah, Hugdikhola and Chhaldi etc. The main attraction of this district is Resunga Forestry. It is very important from the spiritual point of view (DDC profile, 2008).

Gulmi is famous in the coffee plant all over the Nepal. According to possibility and comparative benefit and curiosity of farmers, it is slowly extended in above 32 VDCs by the help of NGO (GARDEEP). In the F/Y 2000/2001 it has been produced 1.40% metric ton in the 54 hector land.

The total population of Gulmi district is 2,97,1,36. Among them 1,34,483 (45.3%) are male

and 1,62,653 (54.7%) are female. There are 59,589 households with 5.0 average household size and has a population density 259 person per square kilometer. The major ethnic groups are Brahman, Chhetri, Thakuri, Magar Churauta etc. (Census and DEO 2001).

Out of the total area (1149 km2), 32145 (37.67%) hector is covered by forest with shrub, 6886 hector is covered by pasture land and 34102 hector is covered by agriculture land and 51568 hector is uncultivated. The major crops are paddy, maize, wheat, millet, barley, potatoes and some pulse. There grows some fruits likewise oranges, banana, guava, mango, litchi and etc. (DDC profile, 2008).

The energy situation in the district is also not satisfactory. Out of total population 17235 consumers are benefited by grid and isolated hydro-power (10453) and alternative energy (6782) with total number of households 66222 (VDC Profile Nepal 2007). The major source of the energy is wood followed by agricultural residue, animal's dung, petroleum products, and electricity. The people consume the energy in traditional pattern which caused deforestation on one hand where as rural women are seriously suffered by health problems on the other hand. The health of women and children is affected by kerosene or wick lamp. There is no developed bio-gas plant in sufficient. It is rare case, a number of few people only installed bio-gas plant i.e. 1318 households (DPN, 2007/8). Many researches show the many possibility and favourable climate to develop the micro-hydro plant but because of lack of the knowledge and high initial cost, this technology has not gained popularity yet as it should be.

In the case of solar plant, it is satisfactory. Gulmi district has remained much ahead of other districts for Solar Home System, in which it stood in the 1st position among the 75 districts in the country. SHS has been reportedly installed in 75 VDCs, which is about 94.9% out of total 79 VDCs in Gulmi. The number of SHS has near by 5000, that is 4736 SHS has been reportedly installed till February 2007. (AEPC, 2007).

Solar plant is getting popularity in day by day in this VDC. It is estimated The district development profile 2007 shows that the energy consumption, 5,103 households (8.58%) out of total households has electricity by national grid and 91.42% of the total households use solid fuels for cooking , lighting and so on. By the end of 2001, it is estimated that one micro-hydro plant has installed by the Hugdikhola about 25 kw for 247 households in Majuwa of Turang VDC (DDC Profile, 2008).

4.1.2 Gwagha Village Development Committe

The study was undertaken at Gwagha VDC of Gulmi district in Nepal. The VDC situated in the hilly region of remote village which is connected with the border line of these VDCs, namely Bhurtung and Phoksing VDCs in East, Harewa VDC in West, Batakachour and Hugdisir VDCs (Baglung) in North and Bharse in South. This VDC lies in North-East part of the headquaeter of the district. The total area of Gwagha VDC is 14.54 square kilometer out of 1,149 square kilometer of district. This VDC lies 1700 meter height. Due to the small area, it could not make the climate can be felt all over the year i.e. there is not so much hot during the summer season too. According to the climate, the village has sub-tropical forest type. The vegetations consists of Payun, Rhododendron, Khursu, Castanopsis (Chilaune), Uttis and Kafal.

The VDC is composed of many tribal and ethnic groups. The dominant ethnic and tribal groups are Brahmins, Chhetri, Magar, Newar, Thakali, Kami, Sarki and Damai etc. who are native and backward groups. Out of the total population 1290 are Magar, 615 are Dalit, 561 are Chhetri 270 are Brahmins, 90 are Newar and 30 are others. (VDC profile, 2008). The religion most of the villagers is Hindu and festivals and religious activities are celebrated according to caste. Dashain and Tihar are two important festivals celebrated by the Hindu.

Most of the houses have zinc thatched roof type and stone (slate) thatched houses are more than grass thatched houses. The wall of houses is made by local stone and soil. The villagers get drinking water supply from private tap, public tap and personal tap also using water from wells and stream. The society gets health service from a sub-health post and one private medical. Similarly education facility accessed by one high school and five primary schools. Furthermore study the people move out of VDC and DDC, like Shantipur, Tamghas, Tansen, Butwal and Kathmandu.

The VDC has all together 524 households with 1228 (43.92%) male and 1568 (56.08%) female. i.e. total population is 2,796. The average family size is 5.59 and average rural land holding by each person is 0.2 hector. The literacy rate in the VDC is 48.4 percent. Among the literacy rate in the VDC, there is vast different between male (85%) and female (47%). Economically, active population is 64,111 male and 86,030 female and economically inactive populations are 28,062 male and 35,694 female. Agriculture is the main

occupation where most of the people's life engaged with cultivation and animal husbandry. Besides this, other subsidiary occupation are foreign job (India, British and overseas) and jobs within the country as teacher, government official, Nepal army, police and in some private sector. Though every household is closely related to the agriculture but the village remained back for the development of technical cultivation procedure and agricultural fields because of less irrigated land, less land of cultivation that doesn't cover the food sufficiency for a year, less family size who stay at home and no expanded market for sale of agricultural products. Similarly, the size of livestock in the village households is also very small. The average number of cattle to each household is nearly two/three. Livestock holding in the village is not undertaken as a professional for cash income but to fulfill only the household needs of milk, butter, ghee, curd and meat. The main type of livestock in the VDC is buffaloes, oxen, cows, goats and pigs. Some domestic birds like hens and duck are also in the interest of some people except Brahmins.

Gwagha VDC is connected by national grid of electricity in few (1/2) wards but the electrification process is not taken place through out of the VDC. The main activity in which the people are facing the energy problems is for cooking food and lighting. Still, almost all, more than 97% households depend traditional source of energy. By this fact, the VDC is not untouched from the deforestation problem. Nobody, was not stalled the bio-gas plant yet. The major energy resources of the study are consisting of fuel wood, electricity, kerosene and solar power.

4.2 Socio-Economic Characteristics of the Sample Households

4.2.1 Age and sex composition structure of the sample HHs

Age and sex compositions are the basic components of the demography. The analysis of age and sex composition of the respondents is one of the essential parts of any research work. So, it plays an important role in the population analysis. Similarly, other population parameters such as occupation, education are also influenced by age and sex composition. It also represents the family structure of the VDC. In this study, the total number of population of sampled households is found 263 persons. Out of total population (263), 131 persons are males, 132 persons are females. The age and sex composition of the sample is presented below in Table no. 4.1

Table no 4.1

Age and sex composition structure of the sample HHs

Age group	Male		Female		Total	
	No.	Percentage	No.	Percentage	No.	Percentage
0 – 14	44	33.5	38	28.78	82	31.18
15 – 30	25	19.08	25	18.9	50	19.1
31 – 45	22	16.7	27	20.4	49	18.6
46 – 60	26	19.84	24	18.2	50	19.1
60 & Above	14	10.6	18	13.6	32	12.17
Total	131	100.0	132	100.0	263	100.0

Source: Field survey, 2009

Above table shows that the population of the female is greater than male in the VDC. Males and females are equal in the age group of 16- 30. The economically active human resource is considered to be 15- 60 age group. Therefore the percentage of working population of the total sample population is 149 (56.65%) where, 27.37% of males and 28.89% of females are economically active and rest 43.34% are dependent on them. Economically active population are lower than national level indicator that 67.3%.

In the study area, there is children population is highest, because they have not only 2 child but also some of them have 5-7 child. Some of them have 3-4 children. So it is greater than other age group. Due to many children and old age persons also high the dependency ratio is high.

4.2.2 Household Size of Respondents

Household size has signification role in the energy consumption. It is found that higher the HH size, higher is the energy consumption and the lower the HH size, lower is the energy consumption. This means with the increase HHs size the energy demand also increase.

Table no 4.2

Household Size of Respondents

SN	Household size	No. of Respondents	Percentage
1	1 – 4	6	16.6
2	5 – 8	21	58.3
3	9 – 12	5	13.8
4	13 – 15	4	11.1
Total		36	100.0

Source: Field survey, 2009

$$\text{Average Family size} = \frac{no.of people living in household}{total households}$$

$$= \frac{263}{36}$$

$$= 7.30$$

Above table shows that the most of the respondents 58.3% HHs have 5 -8 number of family members. Similarly, 16.6% HHs have 1- 4 number of family members. The family size among 9- 12 is 13.8% and the 11.1% HHs have 13- 15 number of family members.

According to the population census 2001, the average HH size of Nepal is 5.45. The HHs of Gulmi district is 5.0 lessthan national. The field survey 2009 has revealed that the average HHs size in the study area is 7.30 higher than national and district level. The study has also found that the largest HH size of the respondents is upto 15 persons in a family. It is due to some join family and some of them have 5/6 children.

4.2.3 Educational Status of the Population

Among the various components education is the key indicator of the human development. It plays an important role in the efforts of any endeavour to uplift a society from repression education is a principal mechanism of fulfilling the minimum learning needs of the people needed for effective participation in the economic, social, political and other activities. Generally, educated people have not only higher income level but also they possess better knowledge about energy resources conservation and efficient uses of energy resources and

promotion of renewable energy technologies and they can adopt the new technologies that ate eco-friendly and energy efficient. This case would not be similar with uneducated and illiterate people because neither they can adopt new technologies not possess knowledge about the technologies. The literacy rate of study is shown by Table no. 4.3 below.

Table no 4.3

Educational status of the sample HHs

Level of education	No. of Persons	Percentage
A. Illiterate	27+12 =39	14.82
B. Literate	224	85.17
Formal (Read & write)	38	14.44
Primary (Grade 1 upto 5)	49	18.63
Lower Secondary (Grade 6 upto 8)	54	20.53
Secondary (Grade 9 upto 10)	45	17.11
Higher Secondary (Grade 11upto 12)	29	11.02
Higher Education (Above 12)	9	3.42
Total (A & B)	263	100.0

Source: Field survey, 2009

Note: Children who are under the age of joining School are also included in illiterate category.

Above table shows that the 14.82% people are illiterate, where include under the age of joining school child are 12 persons. And 85.17% people are literate of the sampling population in the study area. Out of total literate population 20.53% are studying in lower secondary level, 18.63% in primary level, 17.11% in secondary level, 14.44% people have formal (can read& write) education, 11.02% in higher secondary level and 3.42% in higher education (above 12) level. Gwagha VDC has a government secondary school and other five primary schools in different wards.

In the above table indicates literacy people are more than illiterate people. According to the population census 2001, the average literacy ratio of Nepal is 55.1%. The field survey 2009 has revealed that the average education status in the study area is 85.17% higher than national level. Here, standard norms for literate counting is applied which counts only

those in population who can read and write simple sentence of their daily uses in their mother language and also can make simple calculation involving addition, subtraction, multiplication and division. The illiterate level of the VDC is low. Because only few of old man and women are illiterate. Some of them have formal education. Out of total literate population the lower secondary level is high then after primary level is 18.63%. It means there are 82 persons are under 15 years. It shows the no. of children are more than other population. 17.11% are studying in secondary level. 11.02% in higher secondary level and 3.42% in higher education level. Most of people think it is fulfill up to the secondary level and some people have not money ample. So higher education level is very low.

For increase the higher education level there should be increase awareness of people and the government must emphasis on higher education giving some subsidy for higher education.

4.2.4 Dependency ratio of Sample Households

The population of every human society can be divided into two categories namely productive group and dependent group. The ratio between productive group and dependent group is called dependency ratio. According to the national standard population above the age 15 and population below age 60 is taken as productive group.

Table 4.4

Distribution of Dependency Ratio Households population by Age and Sex

S.N.	Age dependency ratio	Male	Female	Total
1	Child dependency ratio	60.27	50.0	55.03
2	Old age dependency ratio	19.17	23.68	21.47
3	Total dependency ratio	79.44	73.68	76.5

Source: Field survey, 2009

The Table 4.4 shows that overall dependency ratio is 76.5 implying that, of 100 working age group population have to support approximately 76 population of not working age.

From the above table this also implies that there is higher dependency ratio in Gwagha VDC. Another fact, shown by above table is that child age dependency ratio (60.27%) is higher than old age dependency ratio (19.17) and the dependency ratio for female is higher

than male.

4.2.5 Occupational Status of the Sample HHs

Occupation is one of the important indicators of the economic status of the people. It also determined the household's wealth, well-being and social stigma in society and plays a vital role of energy consumption pattern. If the people were jobholder or a businessman, they used the modern source of energy like as LPG Gas, Solar electricity, Bio-gas etc. Agriculture has been the main stream of employment and means for livelihood of the rural people. It also creates seasonal as well as distinguished unemployment. But in the study area, there is very low level of agriculture development, because of lack of irrigation, agricultural inputs, training and skill development programme. Many of the people of the VDC are engaged in foreign job. On the basis of primary occupation in the study area, the HHs are engaged on agriculture, service (working in government and private institutions), business (Tea shops and Grocery). Table no. 4.5 shows the occupational structure below:

Table no 4.5

Occupational Structure of the Sample HHs

Occupation	No. of Households	Percentage
Farming	6	16.67
Service without country	6	16.67
Service within country	3	8.33
Business	1	2.78
Blacksmith	1	2.78
Pension	19	52.77
Total	36	100

Source: Field survey 2009

Above table shows that the highest no. 52.77% of HHs have pension, only about 16.67% people are employed in agricultural sector, 16.76% HHs are engaged in foreign job and 8.33% population are engaged in national job. The lowest number of the sample HHS are involved in business and blacksmith; i.e. 2.78% and 2.78% respectively.

It is clear that the agricultural sector is undeveloped and less productivity in the study area. Nowadays, the young generation is going to the foreign countries to join the service sector

for their economic security purpose.

According to above data in the VDC there should be improved in agricultural sector by giving productive skill development training about new method and technologies of agriculture. The government service within the country also low level. There should be need to established small scale industries, giving them knowledge, awareness and education, which can be way of income generation activities for the people.

4.2.6 Annual Income level of Sample HHs

The income of HHs has a great effect on their living standard. It determines the resource mobilization, education and health. Generally it is believe that high level of income increase the quality of life. In the study area, there are many source of income such as agriculture, government job, foreign job, business, labour and other. Especially it is difficult in a society like ours where material wealth is used as a tool to place a family or an individual in the hierarchy of society. As a result, respondents give reply with caution. To estimate the HH income the probable source of a HH income has to be considered, such as sales of agricultural products, animal products, salary, labour income. The annual income level of the sample HHs is shown in table below:

Table No. 4.6

Distribution of Respondents by Annual Income Level

Income level (in Rs. '000)	No. of Respondents	Percentage
Less than 25	1	2.78
25 upto 35	3	8.33
36 upto 45	6	16.67
46 upto 55	10	27.78
Greater than 55	16	44.44
Total	36	100

Source: Field survey 2009

Above table states that most of the respondents (44.44%) have annual income level Rs.55,000 and about 27.78% of sample HHs have annual income between Rs. 46,000 to Rs.55,000. Similarly 16.67% the respondents have Rs.36,000 to Rs.45,000. About 8.33% respondents have annual income level between Rs.25,000 to Rs.35,000 and only 2.78%

respondents have annual income less than Rs. 25,000.

It was found that majority of surveyed HHs have high income because most of HH head are pensioner (Ex-army) of India and British. So they have pension annual above Rs.46,000. And other gained money from agricultural products, animals products, small scale jobs in out of country (likewise India, Malaysia, Dubai, other Arabian countries). The study has also found that low income HHs are heavily depend on traditional energy sources rather than new and alternative sources of energy. It is indicates that 2.78% HHs have low income because his occupation is blacksmith. He has low land and has not any income source.

From the above data shows the SHS energy, the area were being encourage and installed through the British army and Indian army pension is highest. So it is suggested to the government to increase the subsidy amount for the installation of the SHS.

4.3 Energy Use Situation in the Study Area

4.3.1 SHS Installed by Ethnic Composition

In the study area SHS has increasing day by day. The study states the who are the most benefited by SHS. In the VDC, there are many different caste like Brahmin, Chhetri, Magar, Thakali, Newar, Dalit, etc. In this VDC 94.4% HHs have installed SHS. Among them the sampling HHs are installation of SHS by ethnicity presented in table below.

Table No. 4.7

Distribution of SHS According to Ethnicity

SN	Caste	No. of Households	Percentage
1	Brahmin	7	19.44
2	Chhetri	16	44.45
3	Magar	6	16.67
4	Thakali	3	8.33
5	Dalit	4	11.11
Total		36	100.0

Source: Field survey, 2009

Above table indicates that the 44.45% Chhetri have installed the SHS, 19.44% are

Brahmin, 16.67% are Magar. 11.11% are Dalit and 8.33% Thakali have installed the SHS .

The table shows that the Chhetri is high. Because most of Chhetri house head are pensioners. So they need light with eco-friendly. And Thakali are very low due to the no. of household and population also low. Brahmins, Magar and Dalit also some of them are pensioners, foreigner jobholder and national jobholders. So they are also interested to install of SHS.

Even if it is increase rate day by day in the VDC but it is especially high income level family. The initially cost of SHS is very high. So it is not to access of low income level family. So the government should give subsidy for the SHS installation to extend of SHS in rural area.

4.3.2 Total Cost of Installation SHS by Ranges

Solar energy is related to the energy generated by the sunlight. It is a reliable and alternative free energy source for all. Solar system has been contribution as the popular alternative source in the most of the remote and rural communities for lighting purpose. Therefore SPV technology has been proven to be a viable option. This technology considered to be expensive compared to grid extension or mini-grid, becomes not only cost competitive but simple for installation as well, in such far-flung areas with sparse population, often making it the only viable option for electricity supply. The initial total cost of installation SHS by ranges shown in table below.

Table No. 4.8

Total Installation Cost of SHS by Ranges

SN	Cost	No. of Households	Percentage
1	Rs. 10,000 – Rs.20,000	10	27.77
2	Rs.21,000 – Rs.30,000	12	33.33
3	Rs.31,000 – Rs.40,000	12	30.55
4	Rs.41,000 – Rs.50,000	3	8.33
Total		36	100.0

Source: Field survey, 2009

Above table indicates that the initiation cost of SHS installed the highest no. is 33.33%

(Rs.21,000 – Rs.30,000), 30.55% (Rs.31,000 – Rs.40,000) HHs no. is 12, thenafter 27.77% (Rs.10,000 – Rs.20,000), and the lowest no is 8.33% (Rs.41,000 – Rs.50,000).

The table shows that the most frequently installed SHS price is Rs.21,000 – Rs.30,000. thenafter Rs.41,000 – Rs.50,000 and the lowest no. of HHs but highest price is Rs.41,000 – Rs.50,000. Because the price determines according to Wp capacity. Where the bigger capacity is the high price and smaller capacity is lower price. It is clear that the installation SHS regard according to their income level. In above table indicates the highest price is only 8.33%. i.e. no. of sample HHs is 3. Due to their high income level and interested to installed the SHS. Before 11/12 years ago, that is first time in the Gwagha VDC. In before time it was access for elite group of people in the society. And lowest price ranges Rs.10,000 – Rs.20,000 is 27.77% . Because it is going to popular nowadays but Wp is small, but it is most access for low income level group.

Foe expand of SHS in the VDC, the government should give subsidy for the SHS, not only rule and regulation but also in practically. The initiation cost of SHS is very high. It is not to access to low income level group. Small Wp can't give efficient light. Therefore the government should give subsidy with expanding large Wp system.

4.3.3 Distribution of SHS by System Capacity

The installation SHS are various sizes ranging between 20Wp to 65Wp. considering all installations as of taken sample HHs during the field visiting are shown in the table.

Table No. 4.9

Distribution of SHS by System Capacity

SN	System Capacity (Wp)	No. of households	Percentage
1	65	2	5.35
2	50	4	11.11
3	45	3	8.33
4	40	8	22.23
5	36	7	19.44
6	30	1	2.77
7	21	8	22.23
8	20	3	8.33
Total		36	100.0

Source: Field survey, 2009

Above table shows that the two system capacity (40Wp and 21Wp) are same. Which no. of SHS are 22.23% is highest and second is 36Wp i.e. 19.44% HHs. Similarly, 11.11% HHs installed 50Wp, 8.33% HHs have 45Wp and 20Wp, only 5.35% (2) HHs out of sampling HHs have 65Wp system and last one is 2.77% HH has 30Wp.

It found that the most frequently installed SHS size are 40Wp, 36Wp and 21Wp. In above systems the 40Wp and 36Wp were popularity initiation time but nowadays the most frequently installed system size were found to be 21Wp then 40Wp. This indicates that smaller sizes SHS are gaining popularity in the recent year in Gwagha VDC due to low cost and it is accessible for the low income level family.

According to above table I suggest that there should be give more information, awareness to the villagers about the SHS and its benefits with government subsidy. SHS can create income generating activities by the installation of large system capacity.

4.3.4 The Uses of SHS to Operate Different Equipment

Solar Photo Voltaic (SPV) technology has been proven to be one of the best option for electrifying rural and the remote residing homes where there is no other options for lights, which can instantly produced and used locally. A SPV system used for lighting homes and for using of low power consuming electronic goods like radio and TV cassette players etc.

Table No. 4.10

Distribution of Bulbs According to Connection/Operation

No. of bulb	No. of Household	Percentage	Operation no. of bulb	No. of Household	Percentage
1 – 3	6	16.67	1 – 3	18	50.0
4 – 6	21	58.33	4 – 6	16	44.44
7 – 8	9	25.0	7 – 8	2	5.55
Total	36	100.0		36	100.0

Source: Field survey, 2009

In above table shows that the initial connection no.of bulb and daily operation no. of bulb. The table shows the out of total sampling HHs 58.33% HHs joined 4-6 no. of bulbs in their house. Similarly, 7-8 no. of bulbs joined 25% HHs. And 1-3 no. of bulbs joined 16.67%

HHs. If they join 1-8 bulbs they use according their necessity in daily. Above table no. 4.9 also shows the daily operation no. of bulbs. It shows 1-3 bulbs use highest 50% HHs, 4-6 bulbs use only 44.44% HHs and few (2) or 5.55% HHs operate 7-8 bulbs daily.

According to the above table the respondents put the 1-8 no. of bulbs but they operate according to their necessary. Some of HHs uses 7-8 bulbs. It is due to join family and more than two rooms in their house. They use bulbs kitchen, rest room, bed room, guest room, study room, balcony, yard and cowshed. The no. of bulbs determine according to the capacity of solar panel. If they install small size of solar panel they connect few or 1- 3 no. of bulbs and if they install large size of solar panel they connect more than 3 bulbs in their home.

From the collected data suggest to the respondents they should not connect more bulbs out of capacity of their solar panel. It brings the problems the energy capture in the panel. So they can use the large size of panel increase the no. of bulbs.

Table No. 4.11

Operation of Bulbs/hours/day/households

Operation no. of bulb hrs/day	No. of Household	Percentage
2 hour	9	25.0
3 hour	13	36.11
4 hour	12	33.33
5 hour	1	2.77
6 hour	1	2.77
Total	36	100.0

Source: Field survey, 2009

Above table indicates that the 36.11% HHs operate the bulbs for 3 hours in a day, 33.33% HHs operate the bulbs for 4 hours in a day. Similarly, 25% HHs operate the bulbs for 2 hours in a day and only 2.77% HHs operate the 5 and 6 hours respectively in a day.

According to the field survey it found that a respondent operate the average 3-4 hrs in a day which is 6pm to 9pm. Among the sampling HHs some of respondents use the bulbs only 2hrs.Bbecause they fear from the problem. Some of respondents use the bulbs upto 6hrs in a day. It is possible due to large size of panel and children study.

After analyze the data should suggest them don't misuse the energy and don't fear the problem. If users use properly and carefully the equipments of SHS they can operate need hrs in a day. They should careful about the panel.

Table No. 4.12

Operation of Radio/hours/day/households

Operation no. of Radio hrs/day	No. of Household	Percentage
1 – 3 hour	9	11.11
4 – 6 hour	12	44.44
7 – 9 hour	7	25.92
10 – 12 hour	5	18.51
Total	27	100.0

Source: Field survey, 2009

Above table shows the 44.44% HHs play the radio 4-6 hrs in a day, 25.92% HHs play the radio 7-9 hrs in a day. Similarly, 18.51% HHs play the radio 10- 12 hrs in a day and only 11.11% (3)HHs play the radio 1-3 hrs in a day.

It is due to their interest, leisure time and family size. Out of total (36) sample HHs the 27 HHs operate the radio using the SHS. The survey area is village area. They are listening to radio in the morning and evening time. Some of them only 5 respondents listen to 10–12 hrs in a day. It is very much radio love person and he/she likes music, news, education and other information all the day. So they can listen to radio up to 12 hrs in a day.

The respondents in the study area, feel that due to Solar energy

Table No. 4.13

Operation of Television/hours/day/households

Operation no. of TV hrs/day	No. of Household	Percentage
1 hour	5	50.0
2 hour	3	30.0
3 hour	2	20.0
Total	10	100.0

Source: Field survey, 2009

The above table indicates that 50% (5) HHs watching TV only 1 hrs in a day, 30% (3) HHs are watching TV for 2 hrs, and 20% (2) HHs are watching TV for 3 hrs in a day.

According to field survey it found that out of total (36) HHs only 10 respondents have 14" and 15" TV. Television is a entertainment equipment but it is not for all but only high class respondents or elite groups. So the no. of TV only 10 HHs. Even if TV consumes more energy more than radio and light bulb. So people can watch TV only 1 – 3 hrs in a day.

TV consumes more energy, for that the panel capacity also should installed large size. For that the government also should increase the subsidy for SHS in village and for poor people.

4.3.5 SHS: Income Generator or Kerosene and Battery Saver

Once the SHS was installed it was found that the consumption of kerosene by SHS owners significantly decreased in all SHS installed HHs in the Gwagha VDC, whereas the consumption of the batteries decreased only half. The price of kerosene and batteries increase as one goes farther from the road heads due to increase in transportation cost.

Table No. 4.14

Consumption of Kerosene and Batteries by SHS Households Before and After the Installed SHS

Respondents	Consumption of Kerosene (Liters/month)		Consumption of Battery (Pairs/month)	
	Before SHS	After SHS	Before SHS	After SHS
Maximum per family	7	2	5	2
Minimum per family	3	0	1	0
Average per family	5	1	3	1
Price at local market	Rs. 42/ltr	Rs. 55/ltr	Rs.28/pair	Rs.35/pair
Saving by each SHS owner /year	No saving	Rs.2208/yr	No saving	Rs.840/yr

Source: Field survey, 2009

Even if SHS was not directly contributing in income generating but on the other hand it was helping the families to expenses on kerosene and batteries. The families with SHS in Gwagha VDC were saving Rs. 3048 per year on both kerosene and batteries at time of

survey November, 2009.

The SHS had not helped to promote any new income generating activities except for those who were engaged in business such as shops but it had significantly improved the quality of life of the family members, improved their health, and made the work of the family members specially children and women much easier.

Table No. 4.15

Daily Allocation of Children's Time Before and After SHS Installation

Time	Before	Time	After
5:Am	Get up	4:am-6:am	Get up and study
6:pm-7:pm	Do homework of school	6:pm-7:pm	Go to play
7:pm-8:pm	Take meal and help to mother for sometime	7:pm-8:pm	Watching TV/Listening radio
8:pm-9:pm	Study for sometime	8:pm	Take meal and help to mother
10:pm	Sleep	9pm-11pm	Study and sleep

Source: Field survey, 2009

When respondents installed the SHS, they get many benefits from it. SHS has brought some changes to their daily routine as well as increase the study time of their children. Above table shows some changes in daily routine of children of respondents. Their children get up 5am in the morning before the SHS and it is increase by two hours for study time after the SHS. Similarly, the children have got playing time 6pm to 7pm in evening time also increase watching TV/ listening to radio for 1 hour. It is increase about 1hour time in the evening after installation of SHS. They can get some new information, education knowledge and other agricultural knowledge and information, health and sanitation information and population control information and other social awareness from the TV/Radio.

From the above table found that the children's playing time and studying time is increase. Better lighting conditions in houses also help to ease household chores which are generally the responsibility of children for their study. Better lighting in the evening means that children can use longtime in night for study.

Form the survey, all the respondents report that the study time for children has increased

about and average two hours in night time. The children had been sleep at 10pm before SHS. And it is increase study time after the SHS.

4.3.6. Involvement on Productive/Income Generating Work by Using SHS

SHS is a solar power generator suitable for remote areas where small and scattered HHs and non electrified villages because of its standalone and modular features and its ability to generate clean electricity from solar cells. In the study area all the SHS users agree that solar energy is a smokeless neat, clean renewable energy. SHS can only be justified if it is linked with income generating and development activities. The SHS can conduct literacy classes in the evening, educate through TV and can providing SPV light to health posts. There can great opportunity to integrate SPV technology dissemination with income generating and rural development activities. But it was found that during the field study there is no any productive work. Only 4 respondents were operating the telephone as a income generating activity. Which can shown in table below.

Table No. 4.16

Involvement on Productive/Income Generating Work by Using SHS

S.N.	Income generating / Productive work	No. of Households	Percentage
1	Telephone Connection	4	11.11
2	Photocopy / Fax TV Radio, mobile	0	0
3	Repair center	0	0
4	Poultry farming	0	0
5	Knitting, weaving, handicraft	0	0
6	Not involvement	32	88.88
Total		36	100.0

Source: Field survey, 2009

Above table indicates that 88.88% HHs are not involvement in any productive work using SHS and only few 11.11% HHs are involve in income generating activity using by SHS.

It is clear that most of SHS users are unknown about the knowledge of solar energy. It was realized during the field study that only the richer sections of society have in stalled such system. The technology being out of the access of poorer members of the community.

For promotion of the solar technology in remote areas (populated mainly by low-income groups), innovative funding approaches need to be identified. There is also an urgent need for policy guidelines that consider it qualifiable for prioritized credit arrangements together with a subsidy for its dissemination not only theoretically but also practically.

Table No. 4.17

Decision of Respondent for Install SHS

SN.	Decision	No. of Household	Percentage
1	Male	15	41.66
2	Female	9	25.0
3	Both	12	33.33
Total		36	100.0

Source: Field survey, 2009

In above table indicates that the male decision is highest is 41.66%, similarly, both (male & female) decision is 33.33% and female decision is 25%.

It is reveals that male decision is highest because our society is male dominant. But nowadays it is coming with some changing. Where not only male decision but also female alone decision is also 25% and both is 33.33% . Increase female awareness we should give emphasis education for women. And to spread the solar energy technology to aware all people about solar energy giving more information and knowledge.

4.3.7 Application of SHS Components

Solar Home System basically consists of a PV panel, charge controller, deep-cycle battery, DC lights, wires, other accessories are switches, sockets, junction boxes and cable etc. A PV panel, converts the sun light energy into electricity. The electricity generated in the daytime is stored in a deep cycle lead-acid battery and consumed for home lighting in the night. The charge controller controls the charging and discharging process of the battery.

Most of the sample population in the study area agrees that SHS makes them easy to work at night. It has also benefited them for studying, doing other activities, enjoying from entertainment equipments. When installed SHS they should know about all components of SHS. All are important in the view point of solar energy even if battery is most important

than other. So they should use battery properly. The company gives two years guarantee for the battery but the users use carefully and properly it does more than two years. In the study area after the damage battery where should throw they don't know. Lack of knowledge about battery some of respondents sell for kawad, some of throws every where. Which is shown in table below.

Table No. 4.18

Application of Damaged Battery

SN.	After use Battery	Respondents	Percentage
1	Near road	0	0
2	River/stream	0	0
3	Field (Khet/Bari)	0	0
4	At home	13	36.11
5	Company Branch	4	11.11
6	Sell to kawad	3	8.33
7	Dealer	1	2.77
8	No need to throw	15	41.66
Total		36	100.0

Source: Field survey, 2009

Above table states that the 41.66% respondents has no problem to throw the battery till yet. 36.11% respondents put their at home, 11.11% respondents gave the company branch, similarly, 8.33% respondents sell the battery to the kawad and 2.77% respondents gave to dealer without money.

It is clear that most respondents are unknown about damage battery. From the field survey known most of the respondents said that they did not know about this matter while some of them said that they have not though about it as yet. Some respondents selling it to the kawad in Rs. 200- 500/. Most of respondents are keeping their home till yet after damage. Some of them gave company branch and dealer without any money or without replace extra parts. The respondents are not aware of the problem that could arise from improper use of battery.

For the rapid expand and sustainable development of SHS the government, solar energy

company and dealer all of them should emphasis on the training for users, should give knowledge about all parts of SHS and develop it.

4.3.8 Environment Effect by Damaged battery

Solar battery is very useful and important thing if users use properly. A PV panel converts the sun light energy into electricity. The electricity generated in the daytime is stored in a deep cycle lead-acid battery and consumed for home lighting in the night. It has mixed the acid is very dangerous. It may cause wound in the body and skin and may also burn and spoil clothes. Acid may leak if the batteries are not properly stored and maintained or if the battery cover is kept open. In order to avoid injury and accidents from battery. After the damage battery it again cause on the environmental negative effect like water, soil, human health and all environment. So the users should be aware about it but from the field visit it found that most of respondents are unknown about it. Which is shown in the table below:

Table No. 4.19

Environment Effect by Damaged Battery Knowledge of Respondents

Implication	No of Respondents	Percentage
Known	12	33.33
Not known	24	66.66
Total	36	100.0

Source: Field survey, 2009

Table shows most of respondents 66.66% are unknown about it and only 33.33% are known. It is due to lack of knowledge about SHS and its components and training.

Users of SHS should be given training on operation, maintenance of SHS as well as management aspects of battery.

Table No. 4.20

Available of Local Promoter/ Technician

Available of local technician	No of Respondents	Percentage
Yes	7	19.44
No	29	80.55
Total	36	100.0

Source: Field survey, 2009

Above table indicates that the 80.55% HHs have not got the local promoter and 19.44% HHs have got the local promoter.

It is clear that the study area suffering from the problems about SHS. Because only one person is a trained or local promoter in the ward no. 7. He could serve only surrounding area of his home; and he is a new technician. Other remaining HHs feels that very difficult to operate the SHS. Majority of respondents said that here are many technical problems. Nobody (technicians/company agent) came here after installation of SHS. Some respondents installed the SHS before 10 years, some of before 10 months. The problem occurs time and again the components of SHS.

The company or government should give training about SHS repairing and maintenance at least 3 persons at local level.

Table No. 4.21

The problematic part of SHS

SN.	Equipments	Frequent problem	Percentage
1	Panel	0	0
2	Charge controller	9	25.0
3	Distill water	4	11.11
4	Battery	19	52.77
5	Bulbs	15	41.66
6	Main switch	2	5.55
7	Wire	3	8.33

Source: Field survey, 2009

Above table shows that the most frequent problematic component is battery which is 52.77%, second is bulb 41.66%, charge controller is 25%, similarly, distill water is 11.11%, wire is 8.33% and lowest is main switch 5.55%.

This technology is new and it is difficult to convince the villagers to pay for the system who had no adequate knowledge about the technology and were not confident about the technology reliability and its components on the operational aspects of the system. Most of users in the village did not know the basic maintenance of the system. Howsoever the occurrence of certain problems in some of the components e.g. Charge controller, bulbs, battery, distill water are frequent change and replace time after time. Some time the problem occurs in the wire and main switch in low time due to small mistake and lack of knowledge. The respondents expressed that that knew very little on operational aspects, for examples just to switch on or off the light. The only component in which the uses had no any problem is solar panel.

According to the respondents, the items that needed to be repaired include: battery, tube light, charge controller, switch, fuse, re-filling distill water in the battery, carbon on the tube light, cleaning of panel and junction box, etc.

Company and dealer should increase their branches in the local level and repair and maintenance of the machinery center should provide in local level.

4.3.9 SHS Energy Use for Entertainment Before and After the Installation

In human life entertainment is very necessary thing. Without entertainment man can't live easily. So for this purpose anyhow man do enjoy with some equipment likewise radio, TV, cassette player, DVD. For fulfill this purpose they should purchase dry cell battery as energy. In the study area I found all of HHs used radio, cassette player and DVD. Before the installation of SHS they used dry cell battery for the entertainment. When they installed SHS they are enjoying these equipments without dry cell batteries. Because they use SHS for entertainment after installation of SHS. So I found there, all of respondents are very happy with SHS and they are enjoying also. It is clear that the purchase of dry cell battery is reduced. It is also positive effect for the SHS installation SHS.

4.3.10 Main cause for Installation SHS

The individual solar based system is called solar home system, which is being demanded

by more people in rural areas. In Nepal, SHS have been in use for domestic electrification. In the study area after analysis of the qualitative data show that the respondent experienced positive effects of SHS due to reduction or elimination of kerosene consumption, improvement in education, health, in-house environment, income generating activities (use communication), entertainment and information. Their satisfaction can be judged (caused) by the following observations made by them.

- Illumination energy especially outside of house in night time
- Saved cost on kerosene purchase
- Facilitated study particularly of children
- No eye problem during study
- Relieved from smoke of kerosene light
- Got healthy, clean and friendly atmosphere in the house
- Enjoyed with TV, Radio and Cassette player and enhanced knowledge through these audiovisual aids
- Reduction in the purchase of dry cell batteries
- Leisure time to do work in night time and
- Communication etc.

4.3.11 Launching Company in the Study Area

SHS used mostly for lighting purpose and also for listening to radio and playing cassette player, watching Television and charging Telephone and mobile phone. In the study area, there are six different solar companies have been lunching their programs since 2054 to 2066. These companies and service centers are as follows:

1. Suryodaya Pvt. Ltd.
2. Lotus Energy Pvt. Ltd.
3. Leser Sun Energy Pvt. Ltd.
4. Solar Electricity Company Pvt. Ltd.
5. Resh Solar Tatha Pragati Gobar Gas Company and
6. Lakebesi Surya Urja Tatha Gobar Gas Sewa Company Pvt. Ltd. etc.

Among these companies most popular and frequently companies are Lotus Energy, Leser Sun Energy and Suryodaya Pvt. Ltd. Other remaining companies are less use like 1-3 HHs.

CHAPTER-FIVE

USE OF SHS AND THE SOCIO-ECONOMIC IMPACTS

Electricity through a SHS typically sized between 10 to 120 Watt Peak well suits the requirement of rural HHs. And it makes a tremendous difference in life of the rural people. Electricity not only provides them with bright, clean and sage light but it also gives them opportunity to operate other appliances for information, education and entertainment. A recent SHS users survey (sampling 36 HHs) conducted in Gwagha VDC shows 75% (27) HHs of SHS users use solar electricity to operate Radios, 27.77% (10 HHs) to operate TV, 16.67% (6 HHs) to operate cassette players and 44.44% (16 HHs) to operate mobile phone. Rural people are thus benefiting from solar electricity in a number of ways. Other socio-economic values increased day hours for useful activities. Solar electricity has been able to make substantial social impacts in backward rural areas where electricity was a distance dream until few years back. Improved child education due to increased study hours under electric lamps has been cited to be a benefit by most of the users. Having access to electricity information and education also helps rural people to enhance self-esteem. The village poorest have little option but to continue buying kerosene or chop pine trees for fatwood to light the house. Both the kerosene and the fatwood not only contribute to the global problem of climate change, but also create indoor home pollution. So, the SHS is better illustration and reduction in carbon deposited inside the house because of the reduction of kerosene consumption. The rural household also purchases dry batteries for radios and flashlights, which are generally not disposed properly. The purchase of kerosene and batteries account for about 20% of a village HHs income.

Impacts of SHS at the household level can influence not only the general welfare of the household but also lead towards improved economic conditions of the household. However, the latter is a long-term prospect that users can enjoy. This change in economic condition is believed to be indirectly driven through the creation of income generating activities (PCOs, shops) by better lighting facilities and through the provision of better education facilities to children. In addition, time saved in purchasing fuel (kerosene, fatwood, dry batteries) can not be calculated in terms of money saved. Therefore, the only immediate change in the household budget through savings in fuel can be felt by the users but they will also have to bear increased expenditure in operating and maintaining the system.

5.1 Benefits of SHS

Solar system has been contributing as the popular alternative source, in the most of the remote and rural communities. Not only providing much more popularity for remote and rural areas, AEPC has also extended its access ot city or town areas. It has earned more popularity in the city areas due to the existing load shedding. The radiation from the sun can be captured and converted into heat and electricity. Nepal one of the unique and beautiful countries in the world. Most area in Nepal receives high level of sunlight throughout the year. Kerosene based wick lamps are the most common source of lighting in almost all the rural non electrified areas of Nepal. Dry cells are used to power radios and torch lights. An effort has been made to replace the kerosene lamps with energy efficient, cost effective and reliable electric light as well as environmentally friendly batteries and batteryless radios have been designed and developed to protect the environment from the hazards posed by discarded conventional batteries.

5.1.1 Economic Benefit

This is very likely to lead to opening up minds of rural people in far- flung and isolated areas preparing them for faster, broader, effective and sustainable, socio-economic development. SHS installation has not just helped in saving on kerosene, battery, etc. but it opens up new economic opportunities in rural areas. The above mentioned study pointed out that users are using solar electricity in small ways to initiate more productive or income generation activities. There are good examples of establishment of rural enterprises directly related to the business (SHS dealers, service centres and spare parts shops). In whatever small numbers, the dissemination of SHS has directly helped in skill development, employment and entrepreneurship among rural local people of course the extent of creation of economic opportunities depends a lot more on overall improvement of overall socio-economic and political situations in the country.

5.1.2 Environment Benefit

SHS have been installed, and carbon emission has been reduced since the panel replaces kerosene and fatwood as the primary lighting source. Dry cell batteries are no longer used in the village. Instead, villagers use a small NiCad battery recharged via their solar panel. Thus any local ecosystem impacts from improper battery disposal have been substantially reduced. Another, market improvement is seen in the forest conservation likewise,

chopping of pine tree to get fatwood has also been reduced. Due to fatwood and wick lamp reduce the indoor pollution also reduce. So SHS has brought change in the indoor environment. It could save bed room from indoor air pollutions. This was noticed by all of the respondents.

5.1.3 Health Benefit

The elimination/ reduce of kerosene and fatwood use in the home greatly reduced the incidence of respiratory, eye problem and headaches. The sub-health post also received a solar panel and thus is able to provide night time services. On the darker side, more women complained about the sore fingers.

5.1.4 Education Benefit

Children and school students can study during the evening without smokeless light. Under the solar light, they can study for a longer time in compare to sooty kerosene light. Women members are also pursuing literacy class in the sub health-post during the evening.

5.1.5 Reduce Drudgery

Villagers no need to haul heavy loads of kerosene of fetch the fatwood from the jungle to their home. Improved lighting makes the daily task such as cooking and sorting the rice, easier. However, it should also be noted that crocheting the bags to pay off the solar panel loan adds to the work of the women since each bags takes 70 hours to complete.

5.1.6 Gender Focus

Solar PV and the advent of television in the villages have provided opportunities for women to become knowledgeable about the external environment. Better lighting conditions in houses also help to ease household chores which are generally the responsibility of women. Better lighting in the evening means that women can use the evening for income generating activities. The fact that women members are involved in crocheting the woolen hand bags or worked in village cottage industry to produce paper have improved their confidence and self esteem, as solar SHS are installed with their own endeavour. Men members have also started to help their spouse in HH chores such as fetching water, taking care of babies and even knitting the bags.

5.1.7 Poverty alleviation

First, the households no longer need to purchase kerosene or batteries. This saves as much as 20% of the household income. Second once the loans are paid off for the SHS, the income from the sale of bags or the paper products to the women themselves. The additional light provides extra tie in the evening for productive activities.

5.2 Rural Development by SHS

SHS could be installed in any part of Nepal with a small investment and with little external technical assistance, financial spread all over, albeit starting from the homes of the rich among the rural poor. For the groundwork to be done, rural electrification with solar PV systems could be an effective way to stimulate quick and effective rural development in Nepal.

Solar energy is suitable resource of energy, which is non-fossil fuel, non-polluted and clean source. It has the potential to produce electricity through the use of thermal units and photovoltaic cells. Thus, it is comparatively advantageous than other renewable energy sources like hydropower, biogas and wind energy in rural areas. Solar energy helps to improve the health condition of rural women and children due to the reduction of indoor pollution. Solar PV home system is becoming popular in remote parts of the country. These solar PV home systems are used at the household level for domestic lighting and few at institutional level for the communication, lighting for school, temple, health centre etc. Solar home systems are mostly used for lighting, children's study and operation of radio and Television in rural areas. Thus, solar energy will be advantageous for development in rural development.

Subsequently the government realized the need of fulfilling institutional gap that existed in the renewable energy sector. For the promotion and development of renewable energy technology and created on institution known as Alternative Energy Promotion Center (AEPC) under the ministry of science and technology (MOST in 1996). (AEPC, 2007, final report on capacity gap identification of solar PV companies for dissemination of SHS and SHH). It importance is to develop and promote different sources of renewable energy which is essential to economic and social development and for the improved quality of life considering the fact that the maximum utilization of these renewable energy sources could be contribution to sustainable rural development.

5.3 Problems of SHS

Impact of SHS at the HH level can influence not only general welfare of the HH but also lead towards improved economic condition of the HH. The survey revealed that energy expenditure on lighting has increased because of higher capital required for SHS. Nevertheless, SHS has some of the significant negative aspects as follows:

Gwagha VDC is a typical rural village. Which is also suffering from some problems. As the villagers are not getting the periodic repair-maintenance, they are worried about proper functioning of this system. There are not available any big shops, electronic shops except small (Kirana) shops. The people have to move without district to bring their extra parts of SHS. There are no any repairing centers for the SHS. For this work, they have go to the Butwal of Rupandehi district. If The SHS owners are suffering from any difficult parts of SHS likewise bulb, charge controller, battery, distill water etc. they have to go to the Butwal to spent their time and money. The transportation cost is RS. 700 per day. It takes minimum ¾ days to go Butwal and return their home if they have get any problems or maintenance or replace of any components of SHS. SHS users are facing some type of problems that ballast of charge controller was the most problematic component of SHS. It is assumed that one tube breaks down each year. The repairing of ballast or charge controller was around Rs. 200 and a new energy saving tube light cost Rs. 250. Therefore, ther maintenance and repair cost was assumed Rs.200 for first time, which increased to Rs. 300 per year assuming that the price remain same for 20 years. The inflation of the goods, cost on transportation and time spent on going to repair centers were not considered in the calculation.

The technical problems are as follows:

Technical problems with SHS: fusing of bulb and frequent/sudden breakdown of equipment, low durability of charge controller, problem with hazardous chemical (acid) contained in the battery.

Less light in cloudy day and humid place, irregular illumination and light getting extinguished sudden, distill water finishes quickly in the battery.

Non availability of spare parts in local areas.

Respondent's Expectation and Suggestions for the Rapid Expansion of SHS

From the survey, it was found that respondents are attracted by the SHS supported programme and they have positive view- towards it. Most of them suggest and put forward their views as following for the development and rapid expansion of SHS to Company, Dealer and Government:

To the Company

- After installation SHS should be supervision time and again in all SHS.
- Company agent should come for supervision maintenance of SHS's components.
- Company should bring the income generating activities integrating with SHS.
- It should produce and provide reliable and strong spare parts of SHS.
- The manufactures should provide qualified dealers in each VDC.

To the Dealer

- Dealer should provide necessary components of SHS.
- .Dealer also should come to supervision in time and again.
- They have to provide extra parts of SHS when they come for supervision
- Repair and maintenance of the machinery of SHS to local level by providing necessary skill development and repair training.
- Technical and managerial training for related groups.

To the Government

- Government should continue the subsidy, until the technology is totally accepted by the local people.
- Government should make strong policies and do feasibility study is necessary before lunching the programme.
- Government should give awareness programme for the villagers about the advantage of SHS.
- Government should provide with cheap rate than national grid-line.
- If possible, government should provide without any cost for rapid expansion and development of SHS.
- Government should recognize only the guaranteed company for programme launch.

CHAPTER-SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary

Energy, the ability to do work, is essential for meeting basic human needs. The improvement in quality of poor rural life is one of the most cherished goals of all developing countries. This goal can not be achieved in absence of adequate energy and proper utilization of natural resources that a country possesses. Most of the households in our country from rural area where poverty is deep rooted the main reasons behind this are lack of energy and miss utilization of local resources. Because of lack of knowledge regarding AETs and poor economic condition, peoples living in rural area are compelled to use the traditional type of energy sources that has made the pressure on forest resource. Decentralized new and renewable energy systems such as bio-gas, enhanced biomass, micro-hydro, solar, wind and geothermal energy. Nepal, with a per capita energy consumption of about 15 GJ is one of the five least energy consuming countries in the world.

Renewable energy and imported kerosene are among the major sources of energy in the rural areas (Tenth five year plan, 2002-07). To over come from this situation sustainable development of environment resource based energies is a key requirement of a rural based country like Nepal. Thus, alternative energy is the ideal answer to the present energy crisis of Nepal. It plays a vital role for rural electrification.

Solar energy is one of the most important renewable energy in the hilly areas of Nepal. Because Nepal lies in the sunny regions of the world, most part of Nepal receive 6.8 Kwh of solar radiation per square meter per day with 250-300 sunny days a year. Solar energy, experienced by us as heat and light, can be used through two routes: the thermal route uses the required for many purposes in the domestic, agricultural, industrial and commercial sector of the economy such as: heat for water heating, cooking, drying, water purification, power generation and other application; the photovoltaic route converts the light in solar energy into electricity using a device made of silicon or other materials, which can then be used for a number of purposes such as lighting, pumping, communication and power supply in un-electrified areas.

Energy from the sun has many features, which make it an attractive and sustainable option: global distribution, pollution free nature, and the virtually inexhaustible supply (AET, 2007).

This study has analyzed on the impact assessment on the use of Solar Home System of Gwagha VDC of Gulmi district. It was conducted with following objectives:

- To identify the various uses of Solar Home System in the VDC.
- To explore the socio-economic status of Solar Home System user community of rural area.
- To provide, a basis of theoretical as well as practical concept and knowledge for further study and research on rural energy; Solar Home System.

For the fulfillment of the above objectives, the study guided by sample frame from where the total sample is to be around 36 HHs. The research is based on primary and secondary data. For collecting the primary data household survey was conducted. The study has found that merits of SHS, as if not only provide energy for lighting but also helps in improving health, time saving, easy to work at night and comfortable to children's study. In the study area economically active population is more than 56.65 percent. and the educational status of the VDC is found to be nearest of the national average. In the study area, it is found that most of the females are involved in purchasing kerosene before the use of SHS. Nowadays that problem is solved and people are saving their time. Most of the SHS users are reported to have sufficient panel's capacity. It is also found that 11.11 percent HHs are involving on productive work by using SHS. Consumption of kerosene and dry cell batteries has been reduced. There is positive correction between income level and use of SHS. Study analyzed that; poor people cannot afford it easily. Majority of people are benefited from the SHS are higher class ethnic groups than lower class ethnic groups. In the VDC there is lack of linkage between income generating activities and SHS electrification and also training and skill development programme.

For the rapid development and promotion of SHS, the area should be identified and local capability should be built up at village level. For Simple and transparent procedures, loan sanctioning should be developed and institutionalized. Subsidy

policy for SHS should be made consistent. There is a need to integrate SHS technology with income generating activities and proper evaluation and supervision should be done.

6.2 Conclusion

The most necessary thing for human being is energy which is also required for the rapid economic development of the country. So, SHS technology, one of the clean energy technology is being popular in the recent years in Nepal especially in the rural; areas where each and every HHs are staying in dark. Realizing the existing problem of energy, HMG/N has incorporated the SHS installation programme in the seventh plan. And even after the restoration of the democracy in Nepal, the importance of the rural energy has been felt at the policy and decision making level. Raising concern over ecology and the impact on the environment of the use of dry cell batteries and kerosene as a fuel has led to the installation of the SHS in the study area. This technology may provide the scope for maintaining the ecological balance in the study area as well as in the nation as a whole. This smoke free environment in the kitchen and study room improves air quality ultimately leading to improvement in health condition of women, children because they have to always work in kitchen and read with wick lamp.

- Population of the female is greater than male in the VDC, where the economically active population is more than 56 percent and more than 43 percent are depend on them.
- Educational status of VDC is found to be high (85.17%) which is highest than that of national average rate 54.1%, but higher education ratio is low i.e. 3.42 percent.
- Ethnic composition of the study area showed that Chhetri are highest according to installation of SHS.
- It found that the most frequently installed SHS size are 40Wp, 36Wp and 21Wp.

- Foreign Service (pension) is found to be main occupation and the source of income. Only 16.67 percent households are dependent on agriculture which is very low level than national average (81%).

- Annual income level is found that, 44.44 percent households have above 55,000 income in a year.

- During the field visit the researcher found that the SHS is very much popular in Gwagha VDC. The SHS has replaced the kerosene lamps in this VDC. However, as the national grid line for few (1/2) wards has been extended, with only few households wiring but due to it's irregularity the villagers feel that solar is more reliable than grid line.

- However, the occurrence of certain problems can be come. Some of the components can be defects of (e.g. Charge controller, bulbs, distilled water etc) which make the users to by pass charge controller and frequent change of bulbs time after time.

- It is found that the popular end use of the SHS is basic lighting. About 2-5 liters of kerosene consumption is reduced per month per households. But the dry cell batteries are still in use to operate torch lights and tukimara.

- The users are mostly ex-soldiers and pension holders. Therefore the income generating activities by the use of SHS are not found except communication.

- Study has found that only 4 households (11.11%) of the sampling provided national and international telecommunication service to the villagers by the use of SHS. It is also found only 8 households (22.22%) of the sampling are benefited from the use of SHS in their shops.

- All the respondents reported that the study time for children has increased by about an average of two hours in night time. The TV news channel is watched daily by about 27.77% (sampling) households.

- As the villagers are not getting the periodic repair- maintenance, they are worried about proper functioning of the system. Only 1 person (out of 36 households) is trained about SHS.

- There is no subsidy which shall be released at all without obtaining all the necessary information and documents. Proper filing of all the necessary documents is also a very crucial aspect of SHS subsidy.

- The only component in which the users had no any problem is solar panel.

- The study also reveals that there is no any suitable mechanism for the disposal of the used batteries. Some villagers said that they can sell their used batteries in NRs. 200-500 to the waste battery buyers who come to the village time to time. Some of them said they gave it to the repair center/company branch in Butwal free of cost and some of the users are keeping it in the corner of their home till now.

- It is also found that the few users are able to clean panel, level water in the battery, change bulbs, check up the charge controller and can do basic wiring due to the frequent problems but they are not technically trained.

- There is lack of training and skill development programme for the operation and repairing of basic equipment of SHS at the local level.

6.3 Recommendation

- At least, one or two people among the local villagers/ SHS users from each VDC should be trained for basic repair and maintenance of the SHS.

- These recommendations have been derived from the present study. It is recommended that the concerned organization should take necessary steps to implement the recommendations of this study in the coming days.

- There is a need to integrate SHS technology promotion with income generation and social development activities in order to justify the subsidy scheme.

- The SHS's components need to be checked at least once in a year and make corrections accordingly. The basic items regarding the system need to be made available in the village shop.

- Proper evaluation of the socio-economic settings technical and managerial

capabilities and adequate survey should be ensured while carrying out feasibility study.

- Research and Development pertaining to the adoption of solar PV technology are necessary for successful dissemination of the technology.

- The advantages of SHS must be made known to the installers. For this purpose training, seminars and workshop should be indorsed regularly.

- Encouragement should be given to utilize the saved time in the economically productive activities such as income generation as well as recreational and social activities.

- Importance and benefits of the SHS should be broad caste regularly by medium of communication e.g. newspaper, radio, and T.V. etc.

- It is suggested to the government to increase the subsidy amount for the installation of the SHS.

In this way, the study has opened space for further research and it acts as a milestone for supporting them on further research and development. I also believe that finding of this study would help the decision makers at different levels to understand the implication of introducing mass scale SHS for rural electrification in Nepal.

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Appendix – A

Households Survey Questionnaire

I. Structural Questionnaire

Date of interview: .....

1. General Information

a) Name of respondent:.....

b) Sex : [ ] Male [ ] c) Age:..... d) Ethnic Group (caste): .....

e) Village :..... f) Ward No. ..... g) Education Level:.....

g) Name of household head:..... h)Relationship with household:.....

2. Family and Education Information

a) Family structure by age, sex and education level:

Age-group	Male	Female	Education	No. of persons
0- 15			A. Illiterate	
15- 30			B. Literate	
31- 45			Primary (1- 5)	
46- 60			Secondary (6-10)	
60 above			S. L.C.	
Total			Above S.L.C.	

b) Main occupation of family :

a) Agriculture [ ] b) Business [ ]

c. Service/ Government job holder within country [ ]

d. Private job holder within country [ ] e. Labouring [ ]

f. Service in foreign country [ ] g. Others.....

h. Annual income of the family Rs. .....

3. Energy related information

a) What type of energy do you use to lighting before the install of SHS?

i. Bio-gas [ ] ii. Grid line [ ]

iii. Kerosene [ ] iv. Dry cell Battery [ ]

v. Woodfat [ ] vi. Others.....

If "Kerosene" and "Dry cell battery" per month using and saving pattern.

Respondents	Consumption of kerosene (Ltr/month)		Consumption of dry cell battery (pait/month)	
	Before	After	Before	After

4. SHS Related Information

a) When did you install solar home system (SHS) ?

Year .....Month.....Day.....

b) What is the capacity of your panel? .....Watt.

c) How many solar bulbs (lamp) do you have used for lighting?.....

d) Total lighting hours of the solar bulb (lamp) .....hrs/day (average)

e) For what purpose do you use SHS?

i. Lighting [ ] ii. Pumping [ ] iii. Entertainment [ ]

iv. Study of children [ ] v. Social reputation [ ] vi. Others.....

f) What advantages of SHS attracted you most?

i. No need kerosene [ ] ii. Time saving [ ] iii. Improve health [ ]

iv. Easy to work [ ] v. Less expenditure [ ] vi. Others.....

g) Do you think that its easy to work at night using SHS?

i. Yes [ ] ii. No [ ] iii. To some extant [ ] v. Can not say [ ]

If "Yes" which work do you favour:

i. Study [ ] ii. Income generating work [ ] iii. House holding [ ]

iv. Information/Entertainment [ ] v. Others.....

h) Have you done any productive work by using SHS?

i. Yes [ ] ii. No [ ]

If "yes" which those work are ?

i. Knitting [ ] ii. Handy-craft [ ] iii. Communication service centre [ ]

iv. Electronic repaired center [ ] v. Poultry firm [ ] vi. Others.....

i) Solar home system has play vital role for rural electrification. Do you agree?

i. Yes [ ] ii. No [ ]

If "Yes" specify.....

5. Environment related information

a) Do you feel that lighting of SHS is smokeless?

i. Yes [ ] ii. No [ ] iii. To some extant [ ] iv. Can not say [ ]

b) Where do you throw the solar battery after damaged?

i. At home [ ] ii. Near road [ ] iii. River/stream [ ] iv. Fields [ ]

v. Other.....

c) Do you know, what is the adverse effect by damaged battery?

i. Yes [ ] ii. No [ ]

If "Yes" negative effect in .....

i. Human health [ ] ii. Soil [ ] iii. Water[ ] iv. Environment [ ]

v. Other.....

Appendix - B

Unstructured Questionnaire

1. Who is the construction/supply company of your SHS?

.....

2. What is your total instillation cost of the SHS?

Rs.....

3. Have you face any problems to operate the SHS?

If "Yes" what kind of problems.....

4. Which is the most difficult part of using the SHS?.....

.....

5. Did you get local promoter/technicians for checking your solar equipments?

i. Yes [ ] ii. No [ ]

6. How much time was available in home per day to study your children before the use of SHS?.....hrs/day.

7. How much time was available in home per day to study your children after the use of SHS?.....hrs/day.

8. Do your neighbors are getting attraction to use your solar panel? Specify .....

9. What is your suggestion for the rapid expansion of the SHS in the VDC?

For companies.....

For dealers .....

10. What type of help and incentive do you expect from governmental, non-governmental and private institutions?

.....

"Thank You"

Appendix - C

Taking interview with Respondent; while field survey:

Filling up Questionnaires with the Help of Respondents

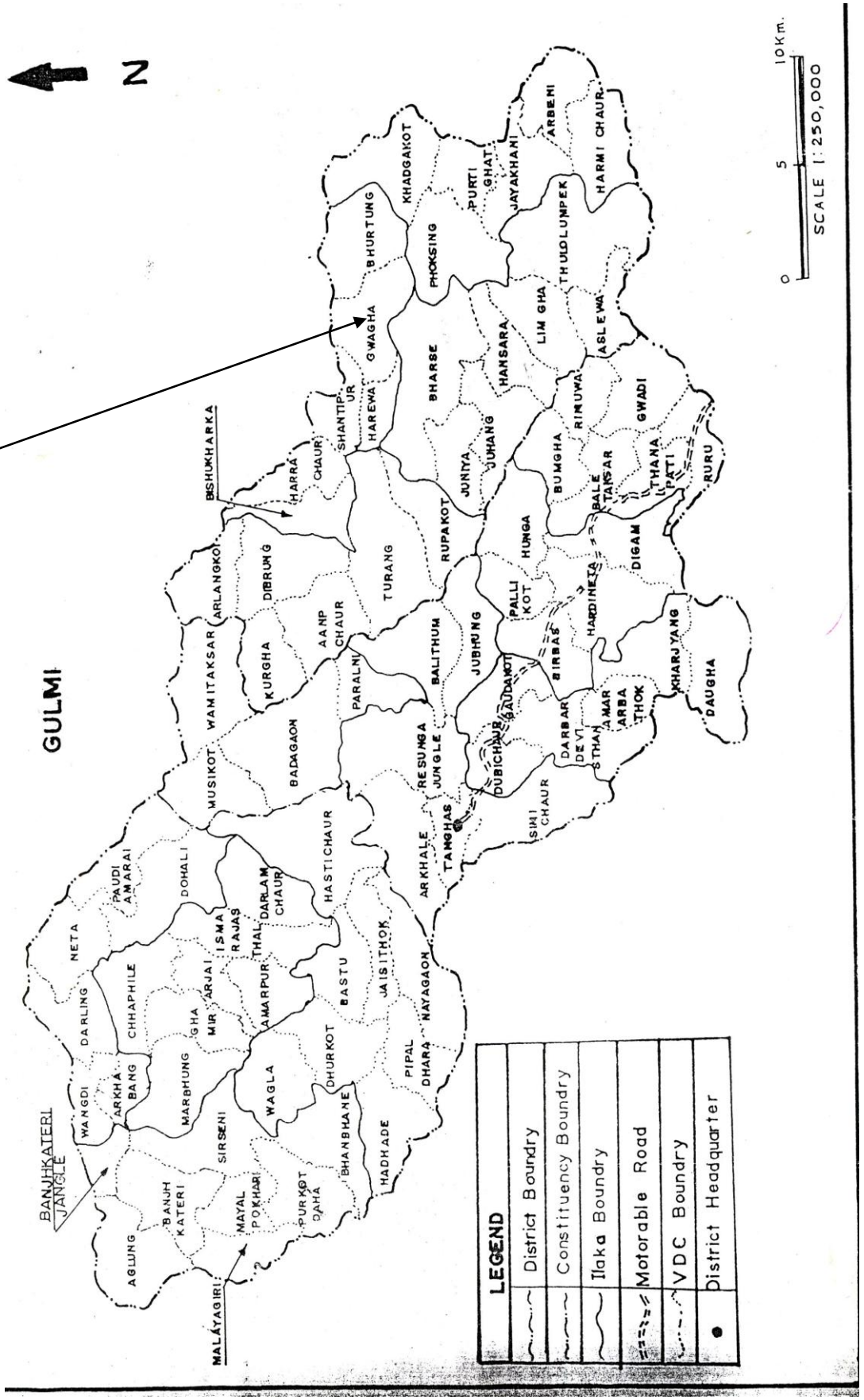
Solar panel use on roof type of slate thatched house.

Solar panel use with help of wood pillar roof type of grass thatched house.

Components of Solar Home System (Solar Panel, Deep-cycle Batteries and Wire).


Nepal
HUMLA
DARCHULA
BAJHANG
BAJURA
BAITADI
MUGU
DADELDHURA
DOTI
ACHHAM
KALIKOT
JUMLA
DOLPA
KANCHANPUR
MUSTANG
DAILEKH
JAJARKOT
KAILALI
RUKUM
SURKHET
MANANG
MYAGDI
BARDIYA
SALYAN
ROLPA
BAGLUNG
KASKI
LAMJUNG
GORKHA
PARBAT
RASUWA
BANKE
PYUTHAN
GULMI
SYANGJA
TANAHU
DANG
ARGHAKHANCHI
DHADING
NUWAKOT
SINDHUPALCHOK
PALPA
KATHMANDU
DOLAKHA
SOLUKHUMBU
KAPILBASTU
RUPANDEHI
NAWALPARASI
BHAKTAPUR
CHITWAN
LALITPUR
KAVRE
MAKWANPUR
RAMECHHAP
SANKHUWASABHA
TAPLEJUNG
OKHALDHUNGA
PARSA
SINDHULI
KHOTANG
BARA
BHOJPUR
TEHRATHUM
RAUTAHAT
SARLAHI
UDAYAPUR
PANCHTHAR
DHANKUTA
ILAM
DHANUSA
MAHOTTARI
SIRAHA
SUNSARI
MORANG
SAPTARI
JHAPA

STUDY AREA


N
GULMI
SCALE 1:250,000
0
5
10Km.
LEGEND
District Boundry
Constituency Boundry
Ilaka Boundry
Motorable Road
VDC Boundry
District Headquarter
BISHUKHARKA
MALAYAGIRI
BANJHKATERI JANGLE
KHADGAKOT
BHURTUNG
PHOKSING
PURTI GHAT
JAYAKHANI
ARBENI
HARMI CHAUR
GWAGHA
SHANTIPUR
HARRA CHAUR
HAREWA
BHARSE
HANSARA
LIM GHA
THULOLUMPEK
ASLEWA
ARLANGKOT
DIBRUNG
TURANG
RUPAKOT
JUNIYA
JUHANG
BUMGHA
RIMUWA
GWADI
WAMITAKSAR
KURGHA
AANP CHAUR
PARALNI
BALITHUM
HUNGA
PALLI KOT
BALE TAKSAR
THANA PATI
RURU
MUSIKOT
BADAGAON
RESUNGA JUNGLE
JUBHUNG
GAUDAKOT
BIRBAS
HARDINETA
DIGAM
KHARJYANG
DAUGHA
ARKHALE
TANGHAS
DUBICHAUR
SIMI CHAUR
DARBAR DEVI STHAN
AMAR ARBA THOK
HASTICHAUR
DARLAM CHAUR
ISMA RAJAS THAL
AMARPUR
BASTU
JAISITHOK
NAYAGAON
DHARA
PIPAL
DOHALI
PAUDI AMARAI
NETA
DARLING
CHHAPHILE
ARJAI
GHA
MIR
MARBHUNG
ARKHA BANG
WANGDI
SIRSENI
BANJH KATERI
AGLUNG
MAYAL POKHARI
PURKOT DAHA
WAGLA
DHURKOT
BHANBHANE
MADHADE

GWAGHA VDC