CHAPTER 1

INTRODUCTION

1.1 Background

Nepal is a landlocked country with no connection with the seaways on its boarder sides. It is the agricultural country and seemed to be in the backward position even with the view of the consumption of energy. About 367 GJ of energy is used in Nepal. With respect to the consumption of energy, Nepal is in the position 142 with the human development index 0.534 according to **World resource institute and world energy organization**. Nepal is recognized as a rural country as about more than 80% of the land is covered by the rural area and almost all of the people in rural area seemed to be using the traditional form of energy like firewood, animal dung in an ineffective way. This has directly affected the development and the living standard of the rural people of Nepal. The consumption of these types of energy not only affects the cost and time but is affecting the environment in negative way. Life expectancy rate, literacy rate and income are directly or indirectly related to energy consumption which is the factors of human development index. The alternative form of energy like solar energy can be the best form of energy in the solution of this problem.

Energy is evitable to sustain human life, to develop human capabilities and generate income for better living. Therefore energy is considered as one of the basic needs of the people. In Nepal, the demand for energy for various users is increasing with the increase in population and need for the self employment. The poor people are suffering disproportionately than the non poor in terms of energy problems. Though there is enormous potentiality of developing hydroelectricity, only 1.3% of the commercial potential has been exploited (MoF, 2006). Rugged topography and harsh landscapes are the major constraint to the extension of modern and clean energy services for majority of rural population in the county. The extension of grid electricity in remote rural areas needs high investment and longer time frame. In the context, there is need of off grid decentralized energy system to increase the access of rural poor to clean energy services particularly in household lighting.

Solar technological advancement and rural development are truly related to each other. The development of the rural area depends upon the types of energy being used and level of the technology for the consumption of that energy. Technological progress improves the quality of existing physical and human resources that increases the quality of the same productive resources likewise; technological progress results from new and improved ways of accomplishing traditional tasks such as growing crops, making clothing building a house etc.

1.2 Statement of the problem

The people in the rural area are used to use the conventional form of energy like fuel wood, animal dung and agricultural residue. This conventional method of energy consumption is not suitable for rural people as it has a lot of negative impacts on the life of rural people. Firstly the rural people have little access to the source of energy like hydro electricity. In addition to this, looking at the economical status of the country it is hard to install the plants for the production of the energy. The geographical structure of the country is also seemed to be the burden for the installation of the infrastructure. To enable the rural people to meet the needs of energy, the renewable source of energy which can be installed through fewer budgets and can be afforded by the rural people should be given more importance. Though some of the renewable sources of energy are being developed in the rural area like micro hydro power, wind energy, biomass and solar energy they are only in the reach of the advantaged people. The solar energy is seemed to be very much effective to uplift the life of the rural people however its initial cost of installation is very much high and is far beyond the reach of the rural people who is unable to earn for hand to mouth.

The government seemed to be unable to install the large cost infrastructure of the energy to meet the energy demand of the rural people. However it is providing certain amount of subsidy for reducing the energy burden among the rural people in the energy devices like solar panel, solar heater etc but they are out of reach of the disadvantaged, marginalized rural people. Elite groups in the villages dominate decision making and they can do neglect the interest of the other people. This raises a question of how democratic is the decision making process when it occurs under social condition of inequality. Many poorer households complained that there is no way they could speak their mind in front of rich people who are taking advantage from the subsidy.

There are some issues and problems still not explored in the field level such as use of user group fund for welfare of poor marginalized people, participation of disadvantage group poor marginalized and women in the decision and planning process for the development and production of community solar energy device, active management of the solar device to derive sustainable yield and impact of solar energy on socio-economic status of user group. These issue require empirical research to explore reliability, if so, it needs detail study researches in these aspects for their validity. This study may give some valid results.

1.3 Objectives of the study

The study is aimed to find out the access of the rural people to solar home system and the role played by it for the upliftment of the socioeconomic status of the people. Specific objectives include:

- To find out the accessibility of the rural people towards solar home system.
- To find out the status of the SHS in the study area
- To study the socio-economic characteristics of the SHS users.
- To find out the extent of utilization of the solar technology by rural people and assess the energy and other benefits from the installed SHS.
- To identify the obstacles, challenges of local community for the solar technologies.
- To suggest the possible effective measures in local context so that the obstacles can be reduced.

1.4 Rationale and Importance of the study

Growing concern for environmental protection and increasing energy crisis demands clean, renewable energy including solar energy. Given the tremendous potential for harnessing solar energy in Nepal, installation of solar home system can be seen as an effective strategy to provide electricity to scattered and isolated rural communities. The establishment of these systems requires considerable initial investment, and therefore justifies the need to evaluate viability and desirability of the SHS in order to ensure that the resources are utilized.

The study is oriented towards finding out the accessibility of the rural people to solar home system and role of that technology in improving the quality of life and their living standard. The solar home system is seemed to be one of the alternatives to reduce the crisis of the energy. Our country Nepal is suffering from the shortage of the energy, and the traditional form of energy which is being used since a long time in a rural area is creating a lot of problems either economic or environmental. Such condition seemed to be affecting the socio economic status of people in the negative direction. This study is also to find out the possibility of the solar home system in that area where it is not being used on the basis of the benefits that are being received by the users. This study might be helpful for the government and the donors to identify as well as to justify that why the solar home system should be given more importance in the context of Nepal for the upliftment of the status of the rural people. The evaluation of these systems will enable the government to formulate adequate policies regarding the promotion of solar home systems in particular and development of rural areas in general. Finding of this may be helpful for the government and donors whether to invest in the solar home system is rational or not.

1.5 Limitation of the study

Due to the limitation of time, this study covers only 30 households. So the finding will be only indicative rather than conclusive. Similarly, study analyzes the average socio-economic impacts of a solar home system and not that of the individual solar home system. The study is limited to the certain socio-economic impacts and its indicators. Thus the validity of the data provided by the respondents hinge upon two main constraints found in the way the data were collected i.e. recall or memory and hiding of information. Most of the primary data were collected through the semi structured questionnaire relied on recall or the memory of the respondents as they have not recorded data. The study was mostly focused on the secondary data. Only the operational months were considered to assess operational cost as well as overall benefits brought about through the solar home system.

1.6 Organization of the thesis

This report is divided into six chapters. In first chapter, introduction, objectives, rationale and significance of the study and limitation of the study has been mentioned. Chapter two is the literature review section which explains about the energy situation in Nepal, concept of solar technology and SHS, situation of solar home system in Nepal and some research findings. Chapter three describes the methodology employed to achieve the study objectives. In chapter four, general description of the project sites, population characteristics, technical and cost specification and the facility at the study area has been explained. Socio-economic impacts of the SHS have been described in chapter five. Chapter six deals with the major findings, conclusion and recommendation of the study signifying the completion of the study report. Bibliography, interview schedule and checklists have been attached as annexes at the end of the report.

CHAPTER 2

LITERATURE REVIEW

2.1 Energy Situation in Nepal

Nepal is dominated by rural areas where 85% of the populations living in rural areas are poverty ridden and about 35% of the rural people are poor (CBS 2001). They are living below average life standard without enjoying even the basic amenities. Poverty in rural areas is reflected in low level of income, low level of literacy and poor health status. Poverty is also reflected in low level of energy use. Though total energy consumption is gradually increasing, per capita energy consumption remained more or less constant and it is about 145 Gega joules. Like other developing countries, Nepal is heavily dependent on traditional energy sources. For year 2005, it shared 87.71% of the total energy consumption of the country. Traditional sources of the country mainly comprises of fuel wood (78.14%), animal dung (5.77%), and agricultural residues (3.8%). Share of commercial (11.76%) and renewable energy (0.53%) is quite low. Out of the commercial sources, the share of petroleum fuels, electricity and coal were 8.19%, 1.82%, and 1.76% respectively. Moreover, energy is mostly consumed in residential sector which is 90.28% of the total energy consumption. Consumption at industrial, commercial, transport and agricultural sectors are 3.48%, 1.45%, 3.78%, and 0.71% respectively (WECS 2006). Though the country has enormous potential for hydropower generation, only 1.5% of the proven commercial potential has been exploited (MOF, 2006). No proven reserves of petroleum suitable for commercial exploitation have been found so far in Nepal. Thus all petroleum products consumed are imported in refined form for direct consumption. Deposits of coal have been identified in Kathmandu valley, mid western part with some economic significance. It is widely distributed throughout the Siwalik range but has not been commercially exploited (WECS, 2006)

The heavy dependency on biomass energy, especially fuel wood, agriculture waste and cattle dung, particularly in rural areas has given rise not only to environmental degradation and irreversible consequences in the country, but also has caused the social burden on majority of the rural women and the large number of children who have to allot about 20% of the work time for fuel collection (Joshi et al., 2003). Similarly kerosene has given rise to economic burden as well as major health and environmental impacts. Therefore, 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 resources 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 renewable energy supply system becomes the natural and feasible choice which includes micro hydro, solar photovoltaic, biogas, ICS etc. And fortunately we also have immense opportunities for developing such renewable energy technologies.

2.2 Introduction to solar energy

Energy can be defined as the ability to do work. It is a theoretical concept that connects different processes in the surroundings. The energy that is found in the rural area under the reach of the rural people is called rural energy. For the complete and the sustainable development of a country there should be the reliable development of energy. The country is seemed to be going to face the problems of the energy crisis in a near future all due to inconvenient and continuous increasing rate of use of energy. People are destroying the forest in the fastest rate i.e. one of the important natural resource of the country and also the strong source of income with the view of tourism. To keep up the interrelationship between the energy and the forest resources it is necessary to bring the concept of renewable and alternative source of energy. It is important to replace the traditional use of the energy and replace them through the alternative forms i.e. biogas, micro hydro project, solar energy, improved cooking stoves etc.

According to rural energy policy, 2063, rural energy refers to environmentally sustainable forms of energy for the completion of the domestic, economic and social purposes in the rural area. The rural energy basically focuses on the renewable form of energy.

Energy from the Sun:

The sun is the big ball of fire. About 70% of the mass of sun is hydrogen with 28% helium and about 2% is composed of heavier elements. The sun is the most abundant and everlasting source of energy on the earth. The energy given by the sun is called solar energy. Sun is the ultimate source of energy and directly and indirectly all the other sources of energy are dependent on the solar energy.

Nuclear fusion is the source of solar energy. The sun is rich in hydrogen gas. At very high temperature and pressure of the sun hydrogen atoms splits up into protons and electrons. Although there is repulsion between protons very high pressure of the sun binds two protons to form a deuteron and a positron. Then a deuteron combines with a proton to give an isotope of helium. The two nuclei of light helium unite to form ordinary helium nucleus. In each step of nuclear fusion a vast amount of energy is released.

$$_1H^1 + {}_1H^1 \qquad {}_1H^2 + {}_1e^0$$

$$_1H^2 + {}_1H^1 \qquad {}_2He^3 + \text{energy}$$

$$_2He^3 + {}_2He^3 \qquad {}_2He^4 + {}_1H^1 + {}_1H^1 + \text{energy}$$

The following conditions make possible the occurrence of nuclear fusion in the sun:

- There is an abundance of hydrogen gas.
- Extremely high temperature causes hydrogen atom to split into a proton and an electron.
- There is huge amount of helium gas.
- Extremely high pressure causes protons to fuse together.

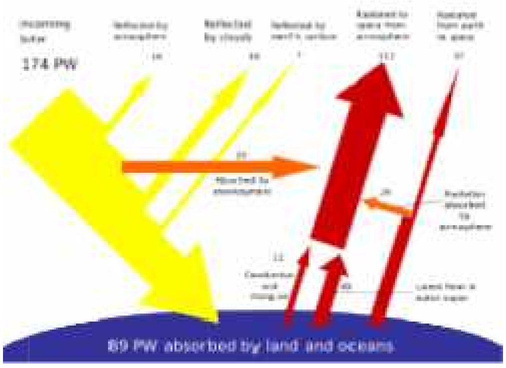

Fig: solar radiation

About half the incoming solar energy reaches the earth's surface. The Earth receives 174 petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

Earth's land surface, oceans and atmosphere absorb solar radiation, and this raises their temperature. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapor condenses into clouds, which rain onto the earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti-cyclones. Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis green plants convert solar energy into chemical energy, which produces food, wood and the biomass from which fossil fuels are derived.

Table 2.1: Yearly Solar Fluxes and Human Energy Consumption

Yearly Solar fluxes & Human Energy Consumption	
Solar	**3,850,000 EJ**
Wind	**2,250 EJ**
Biomass	**3,000 EJ**
Primary energy use (2005)	**487 EJ**
Electricity (2005)	**56.7 EJ**

Source: AEPC survey 2010

The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ) per year. In 2002, this was more energy in one hour than the world used in one year. Photosynthesis captures approximately 3,000 EJ per year in biomass. The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined.

From the table of resources it would appear that solar, wind or biomass would be sufficient to supply all of our energy needs, however, the increased use of biomass has had a negative effect on global warming and dramatically increased food prices by diverting forests and crops into bio fuel production.

Solar energy is the radiant light and heat from the Sun that has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation along with secondary solar resources such as wind and wave power, hydroelectricity and biomass account for most of the available renewable energy on Earth. Only a minuscule fraction of the available solar energy is used.

Solar power technologies provide electrical generation by means of heat engines or photovoltaic. Once converted its uses are only limited by human ingenuity. A partial list of solar applications includes space heating and cooling through solar architecture, potable water via distillation and disinfection, day lighting, hot water, thermal energy for cooking, and high temperature process heat for industrial purposes.

2.3 Solar energy – a viable alternative

Appreciable potentialities of solar energy resources are reckoned to exist throughout the country. With the national average sunshine hour of 6.8/ day, and solar insolation intensity of about 4kwh/ m^2/ day, all the parts of the country has a huge potentiality for solar PV and solar thermal technologies. Solar energy potential of Nepal for solar PV is estimated to be about 26 million MW (CRT, 2005). An estimate of 4636 kWp of photovoltaic power is being utilized in various parts of Nepal for different purposes (WECS, 2006).

2.4 Concept of solar technology

Photovoltaic cells convert sunlight directly into electricity. Photons in sunlight interact with the outermost electrons of an atom. Photons striking the atoms of a semi conducting solar cell free its electrons creating an electric current. The photovoltaic effect was first discovered in the 19th century and was used by Bell Labs in 1954 to develop the first electricity to satellites. These early PV cell were produced in small quantities from exotic materials. While early cells were inefficient converting less than 1% of the incident sunlight into electricity, they quickly increased to 6% when researchers experimented with crystalline silicon, the principal component of sand. Current conversion efficiencies have surpassed the previous achievement and about 15% efficiency is achieved in the crystalline silicon cell PV module.

Two main types of silicon cells vie for market share: crystalline and thin film. Crystalline silicon cells are produced by slowly extracting large crystals from a liquid silicon bath. These crystals are sliced into 1/ 100th of an inch thick slices or wafer which are processed into solar cells that are then connected and laminated into solar modules. While this production process yields highly efficient (10-15%) cells, the production process is expensive. Thin film silicon cells are produced by depositing vaporized silicon directly onto a glass or stainless steel substrate. While the efficiencies achieved are lower than with crystalline silicon the production process is less expensive. Module from crystalline cells have lifetime of over twenty years. Thin film modules will last at least ten years. Other PV technologies such as Gallium – Arsenide or Cadmium – Telluride, are also being used. These types are highly efficient, but more expensive at present time.

PV is measured in units of ‘peak watts’ (Wp). A peak watt figure refers to the power output of the module under ‘peak sun’ conditions considered to be 1000 watts per square meter. ‘Sun hours’ or ‘insolation’, refers to how many hours of peak sun on average exist in different countries. North America averages 3 to 4 peak sun hours per day in summer while equatorial regions can reach above 6 peak sunlight hours.

2.5 Solar home system

It is one of the simple ways to produce the electricity. It converts the solar energy into electricity up to 100 watt. The Renewable Energy in the Rural Market Project supports an innovative approach to rural electrification in Nepal using exclusive concessions to supply dispersed rural homes and public facilities with renewable energy systems on a fee-for-service basis. A solar home system consists of a photovoltaic (PV) solar panel, storage, battery, a battery charging controller, and various end use equipment like fluorescent lamps. Solar home systems can eliminate or reduce the need for candles, kerosene, LPG, and/or battery charging, and provide increased convenience and safety, improved indoor air quality, a higher quality of light than kerosene lamps for reading, and reduced CO_2 emissions. It consists of a solar panel of size according to the necessity of production of the electricity. It is the most important part of the solar home system. The battery, charge indicator, bulb, wires and the switch are the other parts of the system. The solar panel is subjected to sun in such a way that maximum amount of solar energy falls on the panel which is connected to controller through which the battery gets charged. The controller also transfers the energy from the battery to electric load safely.

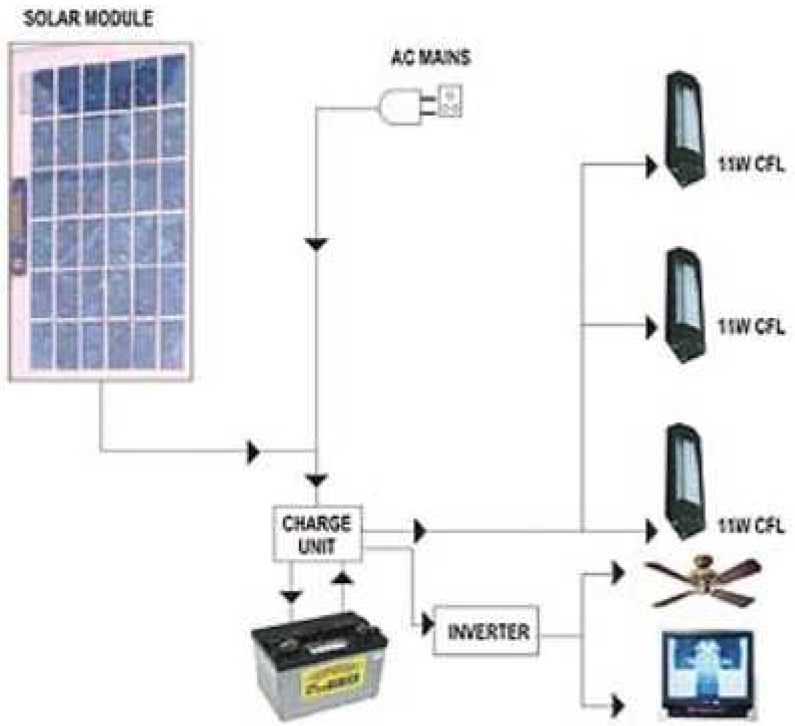

Fig 2.2: Solar home system

The term photovoltaic is derived from the Greek word "phos" meaning light and the word "volt" (named by Alessandro Volta). Photovoltaic is a science, which examines light-electricity conversion, respectively, photon energy-electric current conversion. In other words it stands for light-current conversion. Both direct and diffuse solar radiation takes part of the process. The light to current conversion takes place within solar cells, which can be amorphous, polycrystalline or mono crystalline, according to their structure. In most cases they are made of silicon. Most common application of solar cells applies to pocket calculators power supply, parking meters power supply and similar appliances. Solar-module consists of many solar cells, which are electrically connected and placed between glass and tedlar plate, and framed by an (usually) aluminium frame. A number of solar-modules and other components (batteries, charge regulators, inverters...) can form large photovoltaic systems. Further information on units and symbols used in photovoltaic and in solar energy engineering can be found if you follow the link above.

Solar home systems are also an alternative to grid-based rural electrification. In the early 1990s, the World Bank recognized that solar-home-system technology was maturing, costs were declining, and commercial markets were developing. At the same time, population growth was outpacing the ability of electric utilities to extend rural electricity grids and developing countries were increasingly recognizing the economic difficulties of achieving full grid-based rural electrification. The World Bank and many governments began to perceive that solar home systems could provide least-cost rural electrification and could supplement grid-based electrification policies.

Fig 2.3: Solar home system in study area

Nepal is one of the poorest countries of the world in terms of its GDP per capita and its fuel use. In rural Nepal households generally rely on kerosene and candles for lighting, dry cell batteries for radios and cassette players and wood for cooking. Solar Home Systems (SHSs) have recently been introduced in Nepal but have generally been available only to the wealthier members of society due to their prohibitively high capital costs. In theory the SHSs provide enough energy to displace the traditional fossil fuel based energy used for lighting and radio/cassettes. The level of displacement is not well documented but this case study endeavors to shed some light on how energy use has changed following installation of SHSs, based on several published.

The Government of Nepal aims to increase the rate of household electricity service over the next 20 years. With a largely rural population living in sparsely populated, remote locations, solar home systems (SHS) will play an important role in meeting the off-grid component of rural electrification.

2.6 HISTORY OF PHOTOVOLTAIC

1839 - 1899: Discovery of basic phenomena and properties of PV materials

Discovery of photovoltaic effect:

A physical phenomenon allowing light electricity conversion – photovoltaic effect was discovered in **1839** by the French physicist Alexandre Edmond Becquerel. Experimenting with metal electrodes and electrolyte he discovered that conductance rises with illumination.

First solar cells:

Willoughby Smith discovered photovoltaic effect in selenium in **1873**. In **1876**, with his student R.E. Day, William G. Adams discovered that illuminating a junction between selenium and platinum also has a photovoltaic effect. These two discoveries were a foundation for the first selenium solar cell construction which was built in **1877**. Charles Fritts first described them in detail in 1883.

Other interesting phenomena:

In **1887**, Heinrich Hertz discovered that ultraviolet light changes the voltage at which sparks between two metal electrodes would be initiated.

1900 - 1949: Theoretical explanation of the photovoltaic effect and first

Theoretical explanation of the photovoltaic effect:

The author of the most comprehensive theoretical work about the photovoltaic effect was Albert Einstein, who described the phenomenon in **1904**. For his theoretical explanation was practically proved by Robert Millikan’s experiment in **1916**.

The first silicon solar cells:

In **1918**, a Polish scientist Jan Czochralski discovered a method for monocrystalline silicon production, which enabled monocrystalline solar cells production. The first silicon monocrystalline solar cell was constructed in **1941**.

Photovoltaic effect in other material

In 1932, the photovoltaic effect in cadmium selenide was observed. Nowadays, CDS belongs among important materials for solar cells production.

2.7 History of solar energy and solar home system at national level

First official recorded use of solar electricity in Nepal is not known. But it is said that the Nepal telecommunication corporation (NTC) was the first organization to use solar electricity to power a high frequency communication transceiver located in Damauli in 1974. Since then NTC has become the most significant user of solar electricity amounting to more than 745 kWp generating about 3000 kWh/ day of electrical energy at more than 3500 location, without Nepal electricity authority (NEA) supplied electricity of the country. Similarly the Department of Civil Aviation (DCA) is using more than 20kWp of solar electricity at 45 locations for communication and navigation equipment. NTC and DCA must have chosen photovoltaic technology as the most economic and reliable solution for generating electricity at the locations where grid supplied electricity is not available. So far, there have been no complaints against this technology at those locations probably due to good planning by engineers concerned and also good performance by the solar modules.

The use of solar PV technology for rural electrification in Nepal introduced with 3 mini- grid PV systems installed in 1988 by Nepal Electricity Authority (NEA), with the assistance from the French government. Use of PV power for rural electrification gained momentum only after the successful launching of Pulimarang Village Electrification Projects in late 1993. The success of Pulimarang project played a crucial role in catching the attention of the government towards the PV technology as a means to electrify remote villages and form 1995/96 the government of Nepal started providing subsidy to the decentralized SHS through ADB/N. In 1996, the Alternative Energy Promotion Centre (AEPC) was established under the Ministry of Science and technology with an objective for promoting alternative renewable energy in rural Nepal. AEPC started providing subsidy for Solar PV electrification from 1998/99 but with the establishment of Energy Sector Assistance Program (ESAP) in 1999 for five years as a joint program of the government and Danida, the installation of Solar PV Home System boost up. By 1993/94, there were 3 solar PV companies in Nepal but the prospect of Danida support for the sector surfaced more companies rapidly came to existence.

NEA has a total installed capacity of 100 kWp photovoltaic power at Gumgudhi, Mugu district and Simikot, Humla district for centrally located power transmission. It is reported that these plants are not functioning properly due to technical problems related to balance of system, overloading and low irradiance. All these problems could have been avoided with more careful planning. Perhaps the unsatisfactory functioning of these solar powered installations (installed in 1988/ 89) led energy planners failed to plan implementation properly. This is not a failure of solar energy technology.

Stand alone PV solar home system (PVSHS) is other major application of PV technology in Nepal. The Solar Electric Light Fund (SELF) brought solar electricity to the village of Pulimarang in the collaboration with the Center for Renewable Energy (CRE) in Kathmandu; a nonprofit organization to promote decentralizes energy option for Nepalese rural electrification. With support from the Moriah fund solar home system were installed in 65 homes and community center in Nepal's first solar powered village. Around 90172 solar home systems have been installed in the country by the end of 2005, (CADEC, 2004) covering more than 68 districts (Shrestha, 2006).

2.8 Solar home system in policies and plans

Poverty reduction is one of the prime objectives development plans of Nepal. Accessibility to better form of energy has been one of the means in addressing poverty reduction since implementation of Eight Five Year Plan (1992 – 97). Ninth Plan (1997 – 2002) further emphases this development thought by focusing coordinated approach for rural energy development with the objective of poverty reduction. Moreover, the current Tenth Plan (2002 -2007) emphasizes on strengthening the integrated energy planning approach through decentralization mechanism like the establishment of rural energy development fund at local and district levels.

Among the different provisions required for addressing the issues for poverty reduction the supply of reliable and sustainable electricity is one of the basic requirements. At the end of the ninth five year plan, around 40 percent of population has accessed to the electricity facility. Thirty three percent of population has been connected with national grid and rest 7 percent have electricity facility from alternative energy sources such as micro hydro, solar and other isolated electricity generation plant. To expedite sustainable rural energy supply in year to come, special emphasis has been given to promote rural energy program to ensure services to the poor people. One of such alternatives is solar home system.

2.9 Subsidy

- Subsidy will be provided to households for installing SHS of 10-18 Wp, and more than 18 Wp from now onward as mentioned in following regions.

Table 2.2: Subsidy amount

GEOGRAPHIC LOCATION	10-18 WP (NPR)	MORE THAN 18 Wp (NPR)
Karnali and adjoining districts* and very remote VDCs# categorized A in other districts	7,000	10,000
Remote VDC# categorized B in other districts	6,000	8,000
Accessible VDCs	5,000	6,000
Humla, Jumla, Kalikot, Dolpa, Mugu, Rolpa, Rukum, Jajarkot, Bajhang, Bajura, Achham, Dailekh, Darchula The very remote and remote VDCs of the remote districts are as per Ministry of Local Development (MOLD)/GON notification in the Nepal Gazette. The category "A" comprises of very remote VDCs, while category "B" represents remote VDCs as specified in Annex-1.		

Source: AEPC, 2006

- The subsidy for SHS used by public institutions such as the VDC buildings, School, Club, Health post/ Centre etc. will be up to 75% of the cost.

- In order to provide quick relief from kerosene tuki, jharo etc. in the rural areas a small solar home system (SSHS) based on White LED known as solar tuki will be promoted. A solar tuki consisting of 2-5 Wp solar panel along with two sets of solar lamp will be provided a 50% subsidy on the cost but not exceeding Rupees 1,250 per system.

Subsidy criteria:

In order to be eligible for subsidy, a Solar Home System must meet following conditions.

1. Solar energy subsidy will only be available to Nepalese Citizens for specified SHS and SSHS systems installed in the rural areas not electrified by other means.

2. SHS subsidy will be available when an area or cluster has at least 10 SHS installed from a qualified company or a group of qualified company provided that the ASS arrangements among the companies has been established (they must submit the written agreement for ASS). The area or cluster has been defined in general as a VDC or a group of adjoining VDCs within 3 hours' walking distance and closeness has to be certified by one of the involved VDCs or DDC. However, this condition will not be applicable for SSHS.

3. Installation of SHS or SSHS must be done by qualified companies and its recognized agents/dealers using certified components. In order to ensure NIPQA compliance the systems must use components certified by RETS only.

4. Installation of SHS must be done by a technician certified at least as Solar Electric Technician Level I by the CTEVT.

5. The qualified company must assure that there must be an adequate after sales service (ASS) in the region. In addition, payment due to RETS for certification and inspection of components must have been cleared within 6 months as per the rules of RETS.

6. The subsidy request must be made in the REF prescribed request form.

7. The SHS application form must submit along with a copy of the user's Citizenship Certificate and two photos. The first photo must clearly show the house in full picture with the panel installed, preferably with a proper angle to show the front view of the panel. The second photo should clearly show the user and the installer standing or sitting together with the house as the background.

8. The SSHS application forms may be submitted jointly for up to 10 households buying SSHS and local government representative must duly attest it.

9. Household that has received SSHS subsidy may apply for SHS subsidy after one year.

2.10 Private Sector and the SHS Business

As mentioned earlier, until fiscal year 1993/94, there were only 3 solar PV companies in Nepal. The figure reached 13 by FY 1999/00, which was primarily fuelled by the good news of ESAP coming up. As of today, there are at least 22 solar PV companies registered and operating in the country, out of which 16 have been qualified to participate in dissemination of SHS under ESAP.

Therefore, as there was a preparation going on to launch ESAP, mostly professionals working in the existing solar PV companies started setting up new companies and competed to take bigger share of the growing pie. This spin off phenomenon initially created apprehensions as well as strong rivalry. Fortunately, there has not really been an unhealthy competition or cartel formation for price fixing, etc. Nevertheless, 7 companies came together in 2000 and formed an association called Solar Electric Manufacturers' Association Nepal (SEMAN), with a basic purpose of protecting the interest of the industry and enhancing its bargaining power. Later on, more companies joined the association and it has been increasing able to play roles in protecting collective interest of the industry.

After ESAP came to implementation, companies gradually expanded their sales and service network to different parts of the country. A typical district headquarter in a middle hill today has a number solar PV companies' branch offices or dealers with certified technicians for installations and small stock of the hardware for display.

Currently, the 16 qualified companies have 94 branch or contact offices and 179 dealers all over Nepal, distributed in a ratio similar to the market size in the area. This networking, its expansion and continuity are crucial for sustained commercialisation of SHS dissemination in the country. Quality goods delivered without a workable system for continued after-sales service could jeopardise user confidence forever.

With around 15,000 SHS installed in a year, the current size of SHS market is around US$ 7 million. And the direct and regular employment in the industry is nearly 1,500 mostly people from rural areas joining the sector as sales persons and technicians.

2.11 District wise system capacity and no of system installed

Table 2.3: District Wise System Capacity and no. of system installed

S.N	District Name	No. of systems	System capacity (Wp)	Subsidy amount (Rs)
1	Taplejung	2678	98111	17612200
2	Panchthar	3470	144109	22334800
3	Ilam	2145	98827	13773200
4	Kja[a	28	1351	222000
5	Sankhuwasabha	4971	128685	38782300
6	Terhathum	819	29391	5432000
7	Bhojpur	3253	105016	20524400
8	Dhankuta	1352	41845	8465300
9	Morang	392	16211	2644600
10	Sunsari	15	460	101600
11	Solukhumbu	1805	44054	15000036
12	Khotang	4759	149449	30658400
13	Okhaldhunga	2470	70545	15434000
14	Udayapur	6859	160704	40635200
15	Saptari	156	3912	1052400
16	Siraha	224	6635	1372000
17	Dolakha	1596	29865	10973600
18	Ramechhap	4594	123192	28179400
19	Sindhuli	6879	181810	40909700
20	Dhanusa	126	2952	783850
21	Mahottari	388	10878	2407950

22	Sarlahi	1214	33662	7559850
23	Sindhupalchowk	1100	30509	7629000
24	Kavrepalanchowk	1565	54522	10678800
25	Lalitpur	237	7160	1634400
26	Rasuwa	812	15533	6332200
27	Nuwakot	819	20427	4964600
28	Dhading	3750	106802	23659200
29	Rautahat	383	10270	2334100
30	Makwanpur	3761	71641	22572200
31	Bara	394	9858	2378000
32	Parsa	599	19644	3640400
33	Chitwan	3049	113727	18335400
34	Gorkha	3445	98502	23755400
35	Lamjung	3880	130391	245496000
36	Tanahu	4704	166417	29916200
37	Manang	133	3802	1226000
38	Kaski	1249	40299	8055000
39	Syangja	3080	114079	19625000
40	Nawalparasi	1807	63199	10849200
41	Palpa	3355	91632	21117800
42	Rupandehi	20	556	117200
43	Gulmi	6106	211100	39777200
44	Kapilbastu	84	2704	542000
45	Arghakhanchi	4533	132447	28583300
46	Mustang	815	21187	6896000
47	Myagdi	2549	74972	16910400
48	Parbat	3091	103190	20190400
49	Baglung	3333	111288	22192000
50	Pyuthan	1599	36201	9584600
51	Rukum	11057	230312	103638900
52	Rolpa	14495	299305	135615000
53	Dang	1457	33867	8594000
54	Salyan	3727	78915	21841800
55	Jajarkot	4591	94917	43618800
56	Banke	1069	25831	6406800
57	Bardia	996	23392	6150800
58	Surkhet	2277	50089	13558600
59	Dailekh	6148	123592	60196200
60	Dolpa	3035	60006	25192000
61	Jumla	5299	101415	46667800
62	Kalikot	1706	36457	15870000
63	Mugu	2243	42005	19613000
64	Humla	1379	28423	11958000
65	Bajura	1098	22571	10240000
66	Achham	3235	65747	31308600
67	Kailali	3585	109443	22769350
68	Doti	936	19494	5597600
69	Bajhang	5050	112699	47021470
70	Darchula	6407	149344	58385500
71	Baitadi	2022	43843	12162400
72	Dadeldhura	370	7917	2153600
73	Kanchanpur	702	21918	4404600
	Total	193329	5125225	1425869206

Source: AEPC, 2010

Conceptual framework

CHAPTER 3

RESEARCH METHODOLOGY

The study is based on exploratory field survey. The information has been kept in the tabular forms. The findings has been analyzed and efforts of the local people for the promotion of the solar technology has been studied which has provided knowledge for the development of solar energy.

3.1 Research Design

This study was carried out on the basis of exploratory research design because the study was focused onto investigate the accessibility of the rural people to the solar energy and impact of solar energy on socio-economic condition.

Besides, the study has been made an attempt to describe the things related to solar energy in specific to solar home system. Thus, this study is both descriptive and exploratory.

3.2 Rationale of the selection of the study Area

The solar home system, as an alternative method for the generation energy is being flourished in Jogimara VDC of Dhading district, which does have a significant potentiality. The particular area was chosen for the study because it is easily accessible and interested field.

3.3 Sampling Procedure

The universe of the study was the solar home system users as well as the non users of Jogimara VDC of Dhading District. Out of total people, about 15 HHs of the users as well as 15 HHs of the non users were sampled with quota sampling on the basis of castes.

3.4 Source of data collection

This study aims to explore the impact of solar home system on the socio-economic condition of the rural people of corresponding VDC. Thus, the primary data were collected from the solar home system users of the study area.

Similarly, the secondary data regarding the SHS and its development, history, technological features, positive and negative impacts, present situation and future prospects of SHS in the context of rural areas in Nepal were used for the study, which were collected from published or unpublished written documents from individuals, experts and organization related to solar home system.

3.5 Data collection tools and techniques

To generate the primary data, the structured questionnaire, semi or unstructured interviews as well as focus group discussion method were applied.

3.5.1 Questionnaire survey

Structured questionnaire was prepared to generate the realistic and accurate data from the solar home system users of Jogimara VDC. The questionnaire for the field study was prepared according to the objectives of the proposed study which was finalized after consultations with the corresponding teachers.

3.5.2 Key Informant Interview/ Checklist

The primary data were also collected from key informants using the semi or unstructured interview method. The interview was taken as cross checking for data obtained from questionnaire.

The informants were interviewed on the basis of impact of solar home system on employment, income and agriculture pattern.

Checklists were developed on the basis of information gathered from the desk study. These research tools were finalized based on the feedback received from the pre testing conduction.

3.5.3 Focus Group Discussion

The focus group discussion was held in separate group with the participation of solar home system user. This discussion will be focus on socio-economic status and social participation.

3.6 Data analysis

The help of computer program was taken and simple statistical tools like tables, graphs, measure of central tendency dispersion, co-relation and regression analysis were used for data analysis. The collected primary data and information were arranged in the systematic form in order to meet the objectives of the study.

CHAPTER 4

CHARACTERISTICS OF STUDY HOUSEHOLD AND SYSTEM FACILITY

4.1 Location and accessibility of the study area

This study is carried out in ward no. 1 of Jogimara VDC of the Dhading district. Dhading lies at the central part of the country and Jogimara lies at the south western part of the Dhading district. There are 1211 HHs covering 7318 population in the Jogimara VDC. In the study ward, the total HHs was 202 and the total population was 1212. Jogimara has quite no good access with motorable road. It is 87 km away from Kathmandu valley requiring 4 hrs traveling distance by road bus and then 1 hrs on foot.

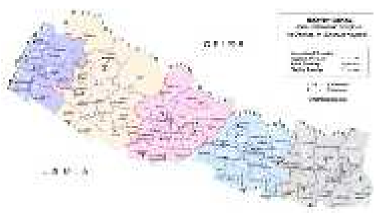

Fig 4.1: Map of study area

4.2 Socio economic characteristics of the study households

4.2.1 Population, sex and age

Table 4.1: distribution of population by sex

S.N	Sex	Users		Non users	
		Number	Percent	Number	Percent
1	Male	55	57.8	57	64.8
2	Female	40	42.2	31	35.2
	Total	95	100	88	100
	Total households	15		15	
	Household size	6.3		5.9	

Source: Field survey, 2010

The distribution of the population by sex is presented in table 4.1. It indicated that about 58 % of user's population was male while about 42 % was female. Similarly about 65 % of the non user's population was male and 35 % was female. The average household size among users and non users are 6.3 and 5.9 respectively.

Among users only about 5 % of the population was below 6 years and 20 % was between the age of 6 to 14 years. Similarly about 65 % population was between the age of 14 – 59 years (which is considered as economically active population) and about 10 % of population was above 59 years. Among non users, 17 % of the population was below 5 years and it was only about 12 % between the age of 6 to 14 years. Similarly about 68 % population had been found between the age of 14 – 59 years and the rest about 3 % had been found above the age of 59.

Table 4.2: Distribution of the population by age.

S.N	Age	Users		Non users	
		Number	Percent	Number	Percent
1	<6	5	5	15	17
2	6 - 14	19	20	11	12
3	14 - 59	62	65	60	68
4	>59	9	10	2	3
	Total	95	100	88	100

Source: Field survey, 2010

4.2.2 Literacy

Among the user's population, about 26 % populations were illiterate. Among the literate population, about 16 % had no formal education. About 8% populations had primary education, 13 % had lower secondary education and 26 % had secondary level education. Similarly about 11 % population were intermediate or above.

Among the non users population about 41 % populations were illiterate. Among the literate population 3 % had no formal education. About 11 % population had primary education, 14 % had lower education and about 22 % had secondary level education. Similarly about 9 % populations were intermediate level or above.

Table 4.3: Distribution of the population by literacy.

S.N.	Literacy level	Users		Non Users	
		Number	Percent	Number	Percent
1	Illiterate	25	26	36	41
2	Literate but no formal education	15	16	3	3
3	Primary	8	8	10	11
4	Lower secondary	12	13	12	14
5	Secondary	25	26	20	22
6	Intermediate and above	10	11	8	9
	Total	95	100	88	100

Source: Field survey, 2010

4.2.3 Occupation

About 17 % user's population had been primarily involved in agriculture and livelihood which was not sufficient for living, 8 % in services, especially in the field of tourism and government sector and 16 % were students. Similarly 32 % were engaged as wage labor, 18 % as household chores and about 5 % were unable to work due physical and mental condition.

Table 4.4: Distribution of population by occupation

S.N.	occupation	Users		Non Users	
		Number	Percent	Number	Percent
1	Agriculture and livestock	16	17	10	11
2	Services	8	8	4	5
3	Study	16	16	12	14
4	Wage labor	32	34	35	39
5	House hold chores	18	20	24	28
6	Unable to work by physical mental condition	5	5	3	3
	Total	95	100	88	100

Source: Field survey, 2010

Among the non users, 11 % population was engaged in agriculture and livestock, 5 % in services and 14 % in study. Similarly, 39 % were engaged as wage labor, 28 % in household chores and 3 % were unable to have any occupation physically.

4.2.4 Health

Distribution of the health related problem among the study population has been presented in table 4.4. Among the user's population, only about 20 % were suffered with such problem during last year and this figure was higher for non user's population. Among the non user sufferers, about 5 % each had infected with pneumonia, 32 % with eye pain, 5 % with ear pain, 20 % with head ache, 24 % with head chest pain, 5 % with asthma, 32 % with cough and 12 % with dizziness. Among the user sufferers, 21 % were suffered from pneumonia, 11 % with eye pain, 5 % with ear pain, 26 % with head ache, 11 % with chest pain, 5 % with asthma, 5 % with cough and 16 % with dizziness.

Table 4.5: Distribution of population by smoke related problem

S.N.	Health problem	Users		Non users	
		Number	Percent	Number	Percent
1	Pneumonia	4	21	2	5
2	Eye pain	2	11	6	32
3	Ear pain	1	5	2	5
4	Headache	5	26	8	20
5	Chest pain	2	11	10	24
6	Asthma	1	5	2	5
7	Cough	1	5	6	32
8	Dizziness	3	16	5	12

	Total	19	20	41	47

Source: Field survey, 2010

4.2.5 Improved cooking stove and toilet facility

It was found that only 42% of the users and 28 % of the non user's household had installed the improved cooking stove and latrine facilities. A campaign is being conducted to facilitate all of the users and non users with such facilities till 2070 B.S. Besides some households had installed biogas plants. Percentage of the SHS user's and non user's households installing bio gas plants has been found as 40% and 20% respectively

4.2.6 Energy consumption

Average annual household consumption of different energy sources was studied. It showed that user households consume less kerosene, fuel wood and battery than non users household. Kerosene was used for lighting, fuel wood for cooking and battery for lighting (battery tuki mara) and radio playing.

4.2.7 Household and personal cleanliness

It has been found out that user's households did clean their house less frequently than non user's households. Average frequency of the daily house cleaning for user's household had been calculated as 3.2 where as it is calculated as 3.8 for non user's households. Similarly the frequency of the monthly cloth washing is also less for user's household than that of the non user's household. It is about 3.5 for users whereas 4.2 for non users. It has been presented in table 4.7.

Table 4.6: Frequency of daily house cleaning and cloth cleaning

S.N.	Activity	User	Non user
1	Daily house cleaning	3.2	3.8
2	Monthly cloth washing	3.5	4.2

Source: field survey, 2010

4.2.8 Land holding

It has been found that the non user's households had smaller land holding size than that of SHS user's household. The average land holding of the user's and non user's households had been found as 13.23 ropani and 8.57 ropani respectively.

Table 4.7: Landholding size of the study population

S.N.	Respondent category	Landholding (ropani)
1	Users	13.23
2	Non users	8.57

Source: Field survey, 2010

4.2.9 Food security/ sufficiency

Food security status of user's households was slightly stronger than non user's households. The average food sufficiency for user's household had been found 10.57 months and that for non user's household as 8.8 months. About 65 % of user's household had the production sufficient for all the year and it is accounted about 52 % for non users.

Table 4.8: Food security and sufficiency condition of study population

S.N		Users	Non users
1	Average food sufficiency (months)	10.57	8.8
2	Food sufficient household (%)	65	52

Source: Field survey, 2010

4.2.10 Technical and cost specification of the solar home system

In terms of capacity, three types of the solar home system have been installed by different company i.e. 20 w, 30 w, and 40 w. however only SHS with capacity 20 w and 40 w are seemed to be most popular in study area.

Here 66.66 % of the total installed SHS were of 20 watt capacity. Likewise 6.66 % were of 30 w and 36.64 %were of 40 w. the average installation cost of the 20 w, 30 w and 40 w capacities have been found as NRs. 22000, 27000 and 29000 respectively including subsidy. The average household cost was found as NRs. 26000.

Table 4.9: Distribution of the installed SHS and installation cost

S.N	Capacity (watt)	Number	Percent	Average installation cost (NRs)
1	20	10	66.66	22000
2	30	1	6.66	27000
3	40	4	26.64	29000
Total average cost				26000

Source: Field survey, 2010

4.2.11 End uses of the SHS

Solar home system has been mainly used for lighting and radio playing. Almost all the households have been used it for lighting. The average no. of the tube lights per households has been found as 4. About 90 % households have used SHS for radio playing and 5 %HH has used it for playing TV.

Table 4.10: End use of the solar home system

S.N	End uses	Households (%)	Average no.
1	Electric Bulbs for lightening	100	4
2	Radio	90	0.9
3	TV	5	0.04

Source: Field survey, 2010

CHAPTER 5

SOCIO ECONOMIC IMPACT OF THE SOLAR HOME SYSTEM

5.1 Educational benefit

Among the user's population, about 26 % populations were illiterate. Among the literate population, about 16 % had no formal education. About 8% populations had primary education, 13 % had lower secondary education and 26 % had secondary level education. Similarly about 11 % population were intermediate or above.

Among the non users population about 41 % populations were illiterate. Among the literate population 3 % had no formal education. About 11 % population had primary education, 14 % had lower education and about 22 % had secondary level education. Similarly about 9 % populations were intermediate level or above.

Pie Chart 5.1 Distribution of population by education

Source: Field survey, 2010

Availability of lighting facility changes the quality of education among population by providing the better environment. However, as it is difficult to measure the impact of the lighting on education within a short period, data regarding the change in the study hrs of children with and without users had been taken as basis for evaluating the impact.

Study shows that children of users group level studies more than those from non users. In some cases, children of the non user's households would come to the user's HH to study. It had been found that the children of the primary, lower secondary level, secondary level and intermediate level or above from the user's household would study 0.25 hrs, 0.28hrs, 1.1 hrs and 1.25 hrs respectively than those of the same educational level from the non users households.

5.2 Health

Distribution of the health related problem among the study population has been presented in table 4.4. Among the user's population, only about 20 % were suffered with such problem during last year and this figure was higher for non user's population. Among the non user sufferers, about 5 % each had infected with pneumonia, 32 % with eye pain, 5 % with ear pain, 20 % with head ache, 24 % with head chest pain, 5 % with asthma, 32 % with cough and 12 % with dizziness. Among the user sufferers, 21 % were suffered from pneumonia, 11 % with eye pain, 5 % with ear pain, 26 % with head ache, 11 % with chest pain, 5 % with asthma, 5 % with cough and 16 % with dizziness.

Pie Chart 5.2 Distribution of population by smoke related problem

Source: Field survey, 2010

The installation of SHS household environments anticipated to improve owing to the better quality and smoke free lighting provision. The anticipated health improvements are conjunctivitis and respiratory problems. With the change from using kerosene to electricity, people avoid exposure to the fumes produced through the burning of kerosene. Similarly children do not have to strain their eyes when studying in the evening. This helps reduce smoke related health problems. These changes can be regarded as an indication of an improved health situation which may point further to the ruse in the level of living standard of the rural people. With the reduction of smoke related health problems, there was reduction of annual household treatment cost and treatment period for users.

In addition to positive effects, negative implication from SHS is also assessed. Nevertheless, majority of the respondents opine no harmful effect of SHS. Only about 5 percent express SHS might have some harmful consequences in the long run. The harmful effects perceive by respondents are acid burning and results from improper handling of battery.

5.3 Increase in wake up time

SHS installation has brought changes into bed time and wake up time thereby increasing total wake up duration for all of the members. Survey result shows that the wake up time has increased by about two hours for adult members whereas the increment is a bit lower in case of children. Details are presented in the fig.

Pie Chart 5.3 Distribution of population on the basis of increase in wake up time

Source: Field survey, 2010

Table 5.1: Distribution of the population responding to change in wake up time

Family members	Time extended due to change in bed/ wake up time in family	
	No of respondents	Average increment
Male	28	2.05
Female	24	2.08
Children	10	1.90

Source: Field survey, 2010

5.4 Access to information

Access to information is the first step towards positive and progressive change in the attitude. Radio, TV programs and audio and video cassette players are modern and the fastest mode of information, which has been found inducted in the users community extensively. Ninety three percent of respondent report they have either listened radio or watched TV or both. Only 7 percent of the respondents don't have access to watch/ listen TV/ radio programs. This indicated that SHS has increased the accessibility of information overwhelmingly.

Pie Chart 5.4 Distribution of population on the basis of device use for information accessibility

Source: Field survey, 2010

It was observed that 7% of the users have accessibility to radio, 3 % to television, 11 % to tape recorder, 25 % to radio and television, 38 % to radio and tape recorder, 9 % to tape recorder and television and 7 % to radio, tape recorder and television.

With regard to accessing information for their knowledge improvement, skill enhancement and entertainment 25 percent of HH watch/ listen agriculture program, health and sanitation program, women development program, religious program, discussion program for knowledge gain and entertainment. It is realize that TV and radio among others have been helpful to enhance the knowledge through better access of information.

5.5 Incidences of accidents

Use of traditional lighting devices e.g. tuki, lantern carry some operational risks such as fire incidences due to kerosene spilling, tumbling of lighting devices etc. SHS carries no such risks, but improper handling of its battery may cause acid burning. Additionally inadequate lighting within the house could cause accidents such as colliding, bumping, and falling from stair etc. resulting into physical injuries. In this context the respondents are queried about incidences of accident after the installation of SHS. This implies SHS installation has been very effective in reducing such accidents without adding any new accidental risks.

Table 5.1: Distribution of the people responding to change in accidents

Types of incidences	Percentage of respondents		
	Increased	Decreased	No change
Incidence of fire	0.28	92.58	7.14
Incidence of physical injuries	0.24	95.33	4.43
Incidence of acid burning	1.18		
Other incidence		5.57	2

Source: Field survey, 2010

5.6 Changes in social and family life

Because of better light quality in the household and extended daily working time, some changes are experienced in the social and family life. The survey indicates that there are few changes in social and family life in the respondents' HH. Family and social/ religious gatherings have increased due to better lighting provision in the evening few incidences of conflict among neighbors are also reported following SHS. This is attributed to jealousy of the neighbors without SHS.

5.7 Household cleanliness

Reduction or and replacement of the kerosene lamps with non polluting electricity reduces the blacking of the walls and ceilings of the house. It also increases the cleanliness of the personal clothes. This helps in reducing frequency of the household and personal cleanliness for the SHS users. The time saved by the electricity facility for daily cleaning of the house and washing clothes has been found very significant. About 3 and half hrs in house cleaning and half hrs in cloth washing per month per HH have been saved by electricity facility.

5.8 Environmental benefit

Solar electricity by its renewable nature is clean energy. Replacement/ reduction of the kerosene lamps definitely reduce the emission of carbon dioxide which is one of the major contributors of green house effect. To certain extent it has played a vital role in conserving the environment and ecosystem.

5.9 Women empowerment

Participation of woman in household decision making is essential for improving the women status in the society. With the improvement in education status of women and their involvement in income generating activities, women are getting empowered. Installation of SHS has reduced women's work load and increased leisure time particularly for three reasons: better lighting reduces strains and enhances work efficiency, secondly it has induces male members and children to participate in household chores, thirdly better lighting provision in the dark enable the women to complete some of the household chores in the night time. The leisure time is seemed to be utilized by women in income generating activities like tika making, embroidery work, grocery etc. facilitation to listen/ watch radio/ TV programs after SHS installation has improved female members awareness on people's right.

5.10 Fuel saving

Prior to installation of SHS kerosene used to be major fuel for lighting and dry cells for radio and tape recorder. However after the installation of SHS, the expenditure on such fuels has been reduced. With the electricity generated by SHS, there is reduction as well as replacement of previous fuel for lighting. Most of the household have been using solar electricity in playing radio and tape recorder which has saved in the expenditure on purchasing battery. Reduction of the battery for radio playing results in reduction in the time spends for purchasing it.

Pie Chart 5.5 Reduction in amount of fuel

Source: Field survey, 2010

5.11 Economic benefit

Agriculture is seemed to be the main occupation of the people. However after the installation of SHS people are involved in IG activities. Although the numbers of such cases are not much, they bear important implication for breaking inertia. People’s involvements in IG activities have important bearing on their empowerment as it enhances their financial independency. SHS have been also helpful to reduce women’s work load and increase their leisure time by better lighting provision which they utilized in IG activities.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

6.1.1 Socio economic profile

Male members are the primary source of survey information in the rural community. It could be mainly because the male generally entertains the outsider and females do not do so. Small family size occupies around half of the surveyed house while another two fifth shares medium of 7 to 10 members and only rest one tenth belongs to large size family.

Larger proportions of the respondents are male Brahman, chhetri (SHS users) and Chepang (non Users of SHS) and economically active age group (14 to 65 years). They are the one who runs SHS and have interest on SHS. Interestingly, the SHS users have possessed relatively good level of education from primary to secondary level.

Economically SHS users are relatively well off families in the rural community. Agriculture is predominant occupation of but not the sufficient one in terms of income. Behind agriculture, labor, business, service are the other occupation followed by the people of study area. Substantial percentage of SHS users belong to higher annual income group and in possession of amenities such as toilet, TV etc. The investment in SHS is also one of the reasons of high expenditure against household income. It appears almost half of the respondents could not meet the SHS cost from their annual savings. This indicates financial support package should be launched with SHS extension programs.

6.1.2 Brief account of SHS

Physically, more than 95 percent of the users have had SHS since last two or more years, thus well familiar about various aspects of the device, such as utility, operational, maintenance/ repairing requirements etc. majority of households have installed SHS for better lighting provision. Neighbors and SHS have played the major role in SHS installation. Decision for SHS installation is dominantly taken by male members.

Fifty seven percent of the users have incurred Rs. 20,000 to Rs. 30,000 for SHS installation. Although the installation cost is largely met by personnel sources, borrowing has been important source for one fifth of the respondents. Despite loan incurred at high interest rate, the loan repayment picture has been quite encouraging. This hints that financing provision for SHS installment may be viable scheme for wider distribution SHS.

More than two third of the SHS users have known about the subsidy provision, but substantial proportions do not have idea regarding subsidy amount and subsidy provider. However, one who is not aware of the subsidy is mainly due to lack of clear explanation of the price break down and the process of getting it. Other reasons may be indifferent in reading instruction sheet, lack of awareness of SHS owners. Unknowingly, several assume that subsidy is provided by banks such as ADB and RBB. Moreover, there is ample scope to better publicize the information. Apparently there is need for better publicity about the available subsidy provision. This would be helpful to induce non using household as well directing credit for subsidy to deserving party.

6.1.3 End uses of SHS

SHS have utility for two broad purposes consumptive and productive. In terms of proportion of users, SHS are mainly used for lighting, and then for radio, TV and tape recorder, in the same order. In the HHs, utilization of SHS exclusively for productive end use has been rare.

Lighting bulbs and connecting TV, radio, VCD and tape recorder are consumptive end uses of SHS. The study reveals better light quality and radio connection are popular end use of SHS. It is observed that lighting is main end use of all the SHS followed distantly by radio and TV connection. Depending on the development stages of the VDC, multiple usages of SHS raised.

Operational hours of SHS reflect the intensity of effects in daily household activities. An average number of bulbs in use for lighting are four. The average total wattage of bulbs used is 24 watts. Similarly, it is computed that daily average operation hour for bulb is 3.36 hours and that of radio is 3.7 hours, TV 2.9 hours and tape recorder 2.01 hours. It concludes the operation hour of radio is longer than that of bulbs and other devices.

Placement of end use devices indicates diversified coverage of SHS usage within HHs. Generally, bulb has been placed in common room and kitchen. This shows almost all owners prefer to light the common room than specific room than specific room such as study room.

Nevertheless, the productive end use is the most desired end uses of the SHS program. Provision of longer working hour and better lighting quality has created some opportunity in breaking inertia of emerging some rural enterprises. Thanks painting, embroidery, apple sapling nursery, poultry farming, tika making, radio/ TV repairing center, cooperative are some of the major income generating enterprises.

SHS has created the rural employment opportunity to the local community in repairing and maintaining SHS sets. Around half of the respondents perceive that local people are capable to run SHS repairing workshop in the village and two fifth are doubtful about this statement.

6.1.4 Socio economic impacts

Comparatively, children are the main beneficiaries and improvement in study environment is the major gain. Better lighting has provided longer study time and facilitated guardians in coaching their school going children at night. SHS has also increased female members' ability to accomplish more household chores because of better lighting and longer working hours. Another change is chatting/ interacting among the family members. Interactions are good for building the understanding among the family members. Nonetheless, a few of the respondents have also reported some increment in drinking alcoholic beverages and gambling habits of the male members.

SHS installation has also increased total wake up time for all of the family members. By alternation in bed time and wake up time, the family members have realized increase in their wake up time by two hours in an average.

Tuki is commonly and widely use prevalent and widely use prevalent lighting device before installation of SHS. This is distantly followed by lantern; petromax etc. kerosene is widely used fuel for lighting and dry cells for radio and tape recorder. Study reveals that SHS has helped in monthly fuel saving. The study points out majority of the respondents have installed SHS for the sake of better lighting followed by kerosene expenditure saving and social prestige.

Access to information is another important impact of SHS. Easy access to audio visual devices such as radio/ cassettes and TV has made the households better informed and enhanced their knowledge and skills. Usually, the TV/ radio programs are watched / listened daily. The news is rarely missed program.

Installation of SHS has also improved indoor environment for most of the respondents. Smoke free environment has brought better health condition especially by reducing respiratory and eye related problems. other important changes are decrease in incidences of fire and physical injuries. Apparently, unawareness and confusion among the SHS owners regarding disposal of used batteries is the one and only problem concerning environment. This calls proper orientation for SHS owners.

Another visible impact is decrease in incidences of fire hazards and physical injuries. However, new incidence of acid burning is emerged causing minor casualty to family members, properties and their belongings.

6.2 Recommendation:

6.2.1 Policy redirection

Existing SHS distribution policy has succeeded in covering only richer and middle class income groups. The subsidy reduction policy has further led to deprivation of SHS access to poor and ultra poor section of the society. Taking into consideration of the disadvantage group, special provision should be made in policy to accommodate such sections.

6.2.2 SHS local service center

Users are deprived of getting post installation service of repair and maintenance. In some of the cases they have to wait for even one to two months to get repaired their ill SHS set. Service center should be made available locally to promote SHS and strengthen the post installation service accordingly. It is also suggested that distributor of SHS should have provision of technical support and training to the local people including women.

6.2.3 Training local technicians

Training local technicians should be made integral part of SHS dissemination process for the successful adoption. The local radio/ TV repairing technicians could be appropriate persons for the SHS maintenance and repair activities as SHS adds synergy in their current work.

6.2.4 Synchronization in after sales service:

Technicians working for one company in the same area do not provide service to another company's SHS set. Because of this users are suffering from even simple maintenance problem. To overcome these problems arrangement should be made to provide after sales services by the available technicians irrespective of their company brand. Initiation should be taken to establish working understanding among the companies to provide services to the SHS users through solar electric manufactures association Nepal.

6.2.5 Transparency in subsidy provision

Most of the SHS users lack experience regarding the availability of the subsidy. They thought whatever they paid to SHS Company that is the total cost of SHS. Finding shows most of the users do not know subsidy provider and exact amount of subsidy. Hence it is suggested that amount of subsidy be clearly mentioned in the price list and subsidy provider widely advertise it through appropriate channel.

6.2.6 Linking with occupational caste:

Despite study results tilted towards little linkage with direct income generating activities, it has tremendous potential to tie up with rural economy. Special intensive program be launched to attract rural occupational communities such as Damai, Kami, Sharki etc.

6.2.7 Intermediary institution:

Institutional support plays important role to reach poor through group formation, loan distribution, SHS distribution in installment basis and secured after sales services. It has already been successful income of the sample VDCs.

Cooperative society; NGOs and the individual members are promoting SHS. Therefore, institutional support should be availed to facilitate the poor people.

6.2.8 Commercial scaling up

Users are confident and ready to posses SHS even in the location with national grid or micro hydro system as energy supply through these systems is not reliable and secured. Moreover, users justified their initial investment with monthly payment in micro hydro and national grid. It is thus recommended that program should be continued in the remote and a very remote area where area is access to poor electricity supply. This could be specifically helpful in scaling up the SHS as commercial enterprises.

6.2.9 Children's perspective

Solar plays a pivotal role in augmenting the awareness and healthy living of the children through watching TV and listening radio. Such access to information generates effective awareness to children regarding harmful effect of cigarette, alcohol, drugs, and the importance of healthy habit e.g. washing hands before taking food. Therefore, it is recommended that the promotional program of alternative energy including solar component should be regularly broadcast. This effort could be further strengthened by including renewable energy resources in the curriculum and school text book mainly in the social studies and science book.

6.2.10 Alternative options to cover poor and ultra poor

SHS is accessible to the income groups having annual income more than 50000. It is clearly depicted from the study that only handful of the poor and ultra poor section of society have access to SHS. Present price index is too high to be afforded by the poor and ultra poor. In order to reach SHS facility to this section following provisions should be arranged:

- SHS model with capacity adjustable should be developed and promoted at cheaper price. This could provide user more flexible to adjust their energy need with initial cost of SHS.

- Soft loan facility should be extended to needy and willing poor in group liability basis and low interest rate.

- Subsidy should be based according to the economic status of the people especially identified by different poverty alleviation program implementing agencies e.g. Small Farmers Development Program (SFDP), Production Credit for Rural Women (PCRW), NGOs, Participatory District Development Program, Local Governance Program, INGOs etc.

- Easy installments program provision could be one of the solutions to reach down to the poor and ultra poor group. Necessary action should be initiated to establish installment system.

- Distribution of SHS on monthly service charge basis is another means of targeting low income group. It is reported that respondents are ready to pay their present expenses on kerosene for lighting.

- Education is most beneficial parameter of the SHS installation. Almost all users express satisfaction over educational performance of their children after installation of SHS. It is recommended that SHS promotional activities should be tied up with different donor agencies related to non formal education, girl child education and adult education. Those who send girls to school regularly and attend adult education should be provided SHS in subsidized rate by the donors.

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Questionnaire

I. Name of the Respondent:

Age: Sex:

Respondent Education Status:

Religion: Occupation:

II. Demographic information:

S.N	Name of the household member	Age group	Sex	Marital status	Education status	Occupation
		(Below 14) -1 (15 – 59) - 2 (60 above) - 3	Male - 1 Female - 2	1 - Married 2 - Divorced 3-Separated 4 - Widow 5-unmarried	1-Illiterate 2-Literate but no formal edu If formal edu, completed years of schooling in years	1-Agriculture 2-Animal husbandry 3-Business 4-Industry 5-Services 6-Study 7-Occupational caste 8-Wage labor 9-Household chores 10-Unable to work others
1						
2						
3						

4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

III. Economic information:

1. Land Holding Size…….. Ropani/ Ha/ Bigha/ Kattha

Land type	Khet	Kharbari	Forest plantation	Others
Before CF				
After CF				

2. What type of animal do you have?

Animals	Total number	Improved Breed	Ordinary Breed
She buffaloes			
He buffaloes			
Cow			
Oxen			

Goats			
Others			

3. Do your production / income suffice family needs for the full year?
   Yes no

   If no, how many months is production sufficient?

4. Could you provide information regarding smoke related health problem of your family this year?

Id	problem	Where did you receive advice for treatment?	How much did you pay for treatment?	How much did you pay for transportation?	Other expenses during treatment	If did not seek take medicine, why?
	1-Pneumonia 2-Asthma 3-Eye pain 4-Ear pain 5-Head ache 6-Cough 7-Dizziness 8-Chest pain 9-Fever	1-Health post 2-Hospital 3-Private health 4-practioner 5-Local healer 6-Treatment at home 7-Did nothing 8-Specify				1-No money 2-No medical 3-No one to take 4-Otheres
1						
2						
3						
4						

5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

5. How much hours do your children read at home?

6. How frequently do you clean your house?

7. How much time to you spend in cleaning house a day?

8. How frequently do you wash your clothes a day?

9. How frequently do your family members take bath per month?

10. Where is the kitchen?

    a) Inside house with partition   b) Inside house without partition

    c) Outside in separate room   d) Outside in open air

11. Is there any provision of indoor air pollution alleviation?

Yes No

If yes what?

12. Latrine available

Yes No

13. Energy use for the household use (monthly)?

S.n	Purpose	Types of energy sources	Quantity consumption		Cost per unit		Collection time
			Before	After	Before	After	
1	Lighting	1.					
		2.					
		3.					
2	Cooking	1.					
		2.					
		3.					
3	Electrical equipments	1.					
		2.					
		3.					

IV. SHS and its impact information:

1. Are you using solar electricity in your house?

2. If yes give information regarding following questions.

a) When did you install solar home system in your home?

Year: ……………   month: ……………..

b) What is the installing capacity?

…………… Watt

c) How do you come to know about the SHS?

…………………………………………………………………………….

d) Did your household contributed in installing SHS?

Yes   No

If yes what kind of contribution had you made?

Contribution	Unit	Unit price	amount
Cash (In Rs.)			
Labor (days)			
Kind (Specify)			
…………			
…………			

e) Did you get any subsidy and grant for installing SHS at your home?

If yes, how much?

a) Subsidy   b) Grant

f) Have you taken loan for installing SHS?

If yes, how much did you borrow, from whom and at what interest rate?

Source of loan:

Total loan:

Interest rate:

g) Is the facility available just now?

If yes then what were the sources of energy you used for daily purposes before the installation of SHS?

…………………………………………………………………………

3. How many electric equipments are you using? Mention the capacity and average lighting hrs/day?

	No	Capacity	Average lighting hours a day		
			Summer	Rainy	winter
Bulbs					
Radio					
TV					
If others (specify)					

4. How frequently did you replace, repair or maintain the electric accessories at household level during last year? Explain the cost of replacement, repair and maintenance?

S.n	Components	Quantity	Unit cost	Charge for technicians	Travel cost	Who beared the cost

					Cost	Days lost	
1							
2							
3							
4							
5							
6							

5. Is there availability of these equipments in local market?

   If not, how far is the market to buy the items in term of distance and total time to reach and back?

   ……………… Km/m ……………… Hrs/min

   Or supplied by company technicians/ others?

6. Is there local availability of technician to undertake repair and maintenance?

7. Do you or family members are capable to replace, repair or maintain the equipments?

8. If the lighting duration sufficient for your household need?

9. Are you fully satisfied with the electricity facility are you enjoying?

   If yes, why?

   If not, why?

10. What is the wake up time

Before ………………hrs per day

After …………….. hrs per day

the installation of SHS?

11. Are you getting any other economic benefits from electricity facility? If yes, mention.

12. Is there any area where electricity facility has added and /or reduced workload to men and women?

13. Is there any program conducted regarding the training of maintenance of simple problem associated with SHS?

14. "SHS is in favors of poverty alleviation of the rural people in the village i.e effects on socio-economic change." What is your view?

15. Do you have something to say on SHS, Please?

Thanks for your cooperation

Checklist – Focus Group Discussion

Analysis on Socio economic impact of SHS
a case study of

1. Location

   District:

   VDC:

   Ward No. :

   Village/ Tole:

2. Date:

   Time:

   Facilitator:

3. List of Participants:

S.N	Name	Sex	Age

4. General Information:

   4.1 Name of the nearest motor head

   4.2 Distance and time required ato reach the nearest motor head:

   Distance: …………Km …………… Meter

   Time: ……………Days, …………… Hrs …………… Minutes

   4.3 Distance and time required to reach nearest electricity grid:

Distance: …………Km …………… Meter

Time: ……………Days, …………… Hrs …………… Minutes

4.4 Total no. of the HHs and population covered by solar energy:

HHs ……………

Population ……………

4.5 Total population of the VDC: ……………

4.6 Total Population in the ward: ……………

4.7 Lighting and electricity facility in neighbors: ……………

4. Installation and facility

4.1 Adequacy of electricity facilities

4.2 Peak lighting month

4.3 Low lighting month

5. Impacts of the SHS

5.1 Health and sanitation

5.2 Education and information

5.3 Saving (time, money etc.)

5.4 Women empowerment

5.5 Access to information

5.6 Increase in wake up time

5.7 Change in social and family life

5.8 Income generation

5.9 Environment protection

5.10 Other benefits

6. Negative impact of the solar energy

6.1 Work load increases

6.2 Higher expenditure for lighting

6.3 Debt problem

7. Incidence of accident

   7.1 Repair and maintenance

   7.2 Availability of technicians for repair and maintenance

   7.3 Ability of the users in general repair and maintenance

   7.4 Local availability of repair and maintenance of equipments

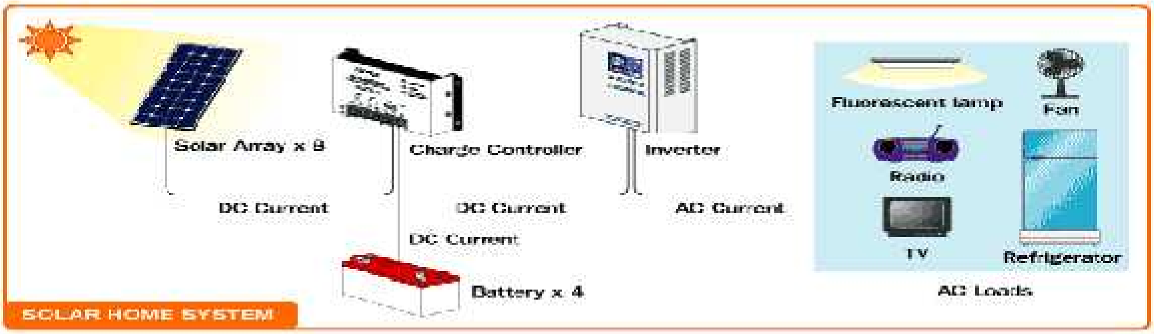
8. Sustainability

   8.1 Affordability of repair and maintenance cost by users

   8.2 Acceptability of the technology

   8.3 Ways for making SHS sustainable

Thanks for your cooperation


Solar Array x 8
Charge Controller
Inverter
Fluorescent lamp
Fan
Radio
TV
Refrigerator
DC Current
DC Current
AC Current
DC Current
Battery x 4
AC Loads
SOLAR HOME SYSTEM