

CHAPTER -ONE

INTRODUCTION

1.1 Background of the Study

Nepal is situated in the northern hemisphere, known as land of Mt. Everest and the birth place of Lord Buddha, Nepal is a small landlocked country. Though Nepal occupies only 0.03% and 0.3% of total land area of world and Asia respectively, the country has an extreme topography and climate. The altitude ranges from 70 meters to 8848 meters and the climate varies from tropical to arctic depending upon altitude. The country stretches from east to west with mean length of 885 kilometer and widens from north to south with mean breadth of 193 kilometer.

Geographically, the country is divided into three East-West ecological zones: the Northern Range – Mountain, the Mid Range – Hill and the Southern Range –Terai (flat land). In the northern range, the Himalayas form an unbroken mountain range which contains eight peaks higher than 8,000 meters, including Mt. Everest on the border with China. The middle range is captured by gorgeous mountains, high peaks, hills, valleys and lakes. The Kathmandu valley lies in this region. The southern range with almost 16 km. to 32 km. North-South consist of dense forest areas, national parks, wildlife reserves and conservation areas and fertile lands.

At present, the country is divided into five north-south administrative development zones: Eastern Development Region, Central Development Region, Western Development Region, Mid-Western Development Region and Far-Western Development Region. The country is further divided into 75 administrative districts. Moreover the districts are further divided into smaller units, called Village Development Committees (VDCs – total 3625) and Municipalities (133). The VDCs are rural areas, whereas municipalities are urban areas of the country.

According to the National Population Census 2011, the annual growth rate of population is 1.35 percent and the total population of the country in 2011 has reached about 2,64,94,504 with sex ratio 94.2.

The preliminary estimate of per capita GDP at current prices stands at NRs. 57,726

(US \$ 735) for the year 2011/12. The economic growth of the country measured by GDP is 4.63 percent per year in the year 2011/12. About one fourth of the population (25.16%) lives below poverty line as per the Nepal Living Standards Survey 2010/11 and the Gini-Coefficient; which indicates inequality in income distribution, is 0.328.

Energy is a vital input for many everyday activities like cooking, heating, lighting, etc. The backbones of modern society – agriculture, health sector, transportation, education, and industry rely on it.

In the context of Nepal, the energy mix is characterised by the dominance of traditional sources, followed by commercial and renewable. About 85 percent of the total energy consumption in Nepal is met through traditional biomass. Out of the total biomass, firewood contributes about 89 percent, animal waste 7 percent and the remaining 4 percent from agricultural residues. The rest is met through commercial sources: petroleum

Energy resources coming under the commercial or business practices are grouped into commercial energy resources that particularly include the coal, grid electricity and petroleum products. Biogas, solar power, and micro level hydropower are categorized into the alternative energy resources in Nepal. Such resources are considered as the supplement of conventional energy resources. Total energy consumption in the year 2008/09 was about 9.3 million tons of oil equivalents (401 million GJ) in the country out of which 87% were derived from traditional resources, 12% from commercial sources and less than 1% from the alternative sources.

Energy is taken as one of the most important indicators of socio-economic development, and per capita energy consumption is often viewed as a key index of the development. Developed countries have significantly higher per capita energy consumption. For example, the United States has a per capita energy consumption of 314.1 GJ/year; Japan has 162.5 GJ/year. For Nepal, the per capita total primary energy supply (TPES) is just 14.2 GJ/year, which is far less than world's average per capita TPES of 76.6 GJ/year. Nepal though being rich in water resources possessing around economically exploitable hydropower potential of about 42,000 Megawatts (MW) is facing a severe power shortage up to 12 to 14 hours per day since last 6/7 years. "Electricity is a distant dream for many families in rural area of Nepal, 63% people don't have access on electricity. The discrimination is even higher when it

comes to rural area, only 30% of rural people have electricity access while around 90% of urban people are connected with electricity”(Power and People, AEPC 2010). There is continuously increasing demand for electricity for households as well as for industrial and for other many purpose.

Nepal’s energy sector heavily rely on traditional sources. Dependence on traditional sources is 87%, Commercial 12% and renewable 1% of total energy consumption. The figure of total energy consumption by fuel types is: Fuel wood 77.7%, Petroleum 8.2%, Coal 1.9%, Electricity 2.0%, Biogas 0.6%, Agriculture residue 3.7%, Animal Dung 5.7%, the contribution of solar and micro hydro is very low(Water and Energy Commission Secretariat, 2010).

The energy consumed by sector for 2008/09 is by Residential 43.4%, Industrial 38.2%, Commercial 6.9%, Agriculture 2.1%, Transport 0.2%, Others 9.1% (Synopsis Report WECS, 2012) As we all know these massive uses of traditional energy threat the sustainable development of country and the dependence on the imported fossil fuel; the rising price of fossil fuel in the international market is a burden on its foreign exchange and result trade deficit.

Energy is one of the vital inputs to livelihood and consistent availability of affordable energy sources are the prerequisites of socio-economic development of Nepal. 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, it’s hard in providing basic necessities also because of inadequate infrastructure development, scattered rural households, high cost of centralized national grid power supply and poor purchasing power of the people.

The use of Renewable energy technology can reduce the dependency on traditional energy and help to protect the environment. It also plays crucial role in increasing people access in information technology and helps in accelerating the economic activities in remote areas of the country. Renewable energy resources are the energy resources that are obtained from sources that are replenished by nature. Some examples of renewable energy resources include moving water (hydroelectric power, tidal power, and wave power), thermal gradients in ocean water, biomass and bio wastes (bio energy and bio-fuels), geothermal energy, solar energy, and wind energy.

Renewable energy resources (hydroelectric power, solar energy, biomass and bio-waste) are sustainably available in Nepal and therefore, adequate utilization of these resources could certainly complement the country's renewable energy portfolio. Being environment friendly, renewable energy also contributes to significant reductions in greenhouse gas (GHG) emissions, local/indoor air pollution, and minimizes the impact on the landscape, and physical, geographical and natural environments. A decentralized renewable energy system is likely to improve the life quality of the rural population in Nepal.

Solar energy was first conceived as a viable alternative form of power as early as in the 1860s when coal was expected to be running out of supply. The oil crisis of 1973 brought renewed attention to the potential of solar power as alternative source of energy. In response, industrial countries made a concerted effort to develop solar power (Status of Solar Photovoltaic Sector in Nepal, AEPC 2010). The first recorded use of Solar PV in Nepal can be traced back to 1963 when Civil Aviation Authority of Nepal installed a Solar PV system in Bhadrapur Airport to run navigation equipment. Its use for domestic electrification started in 1992/93 and gained momentum from 1996 when Alternative Energy Promotion Centre (AEPC) was established. To promote rural electrification through solar energy, Government of Nepal, in partnership with Danish, Norwegian and German governments, has introduced subsidy program to encourage the adoption of solar home system. The scheme is known as Solar Energy Support Program (SSP) and is one of the components of Energy Sector Assistance Program (ESAP) which is nested within Alternative Energy Promotion Center.

Solar PV Home System is the system in which the energy from sunlight is converted into electricity. It is the household electricity supply system with Solar Photo Voltaic panel of capacity of 5Wp to 10 WP and more, and bundled with battery, battery charge controlling mechanism and appropriate number of lights."Solar Home System (SHS) is defined as the household electricity supply system with solar photovoltaic panel of capacity 10 WP or more and connected with battery, charge controller and appropriate number of DC lights" (AEPC, 2006). AEPC/ESAP started providing subsidy for SHS through interim rural energy fund(IREF)from April 2001. Total installed capacity of Solar PV in Nepal is more than 9 Megawatt (9,123,668Wp ,

AEPC, Status Of Solar Photovoltaic) .It is estimated that over 390,000 population have access to electricity from these systems. AEPC has targeted to install 80,000SHS by providing subsidy by of Rs 640000000 for fiscal year 2010/11(Subsidy Disbursement status of SHS, 2012, AEPC). A total of 336000 units of SHS have been installed in 73 districts till December, 2012 and the trend is in increasing numbers. The budget for the fiscal year 2013/14 has allocated Rs 1.11 Billion to install solar energy plant in 125,000 low-income households.

1.2 Statement of the Problem

Energy is indispensable in modern societies. We need energy for home appliances, lighting, transportation, cooking, heating/cooling, communication, and industrial processes to produce and supply commodities of our daily needs. Thus, energy is one of the most important indicators of socio-economic development and plays vital role in increasing and improving the living standard.

As we know that Nepal is in Energy Crisis. About 83% of the total population lives in rural areas. More than 87% of Nepal's total energy demand is being met by traditional sources. Though Nepal possess about 2.27% of the world hydropower potential, less than 2% of its total energy demand is being met by electricity. The access to electricity is even low and inequitable particularly in the poor rural areas. Even in electrified areas, there has been an acute power shortage in recent years, with residents forced to live up to 14 hours of daily load shedding. In most of the rural areas, people are still using kerosene lamps, which is expensive as well as they are not easily available.

Very difficult terrain and scattered settlements makes centralized grid supply to all the population in Nepal very difficult. Photovoltaic technology is deemed to be one of the most appropriate means to provide electrical energy for various applications in remote areas of Nepal. (Shrestha, et al.2003)

On average Nepal has 6.8 sunshine hours per day with the intensity of solar insolation ranging from 3.9 to 5.1 kWh/m²-day (the national average is about 4.7kWh/m²/day) Using photovoltaic (PV) modules of 12% efficiency and assuming peak sunshine of 4.5 h per day, the total energy generated would be 80,000 GWh/day or 2064 million

tons of oil equivalent (Mtoe) per year. This energy would be nearly 17% of the world's total primary energy supply (TPES), which is estimated to be 12,267 Mtoe for the year 2008. If we use just 0.01% of the total area of Nepal, we can generate solar electricity at 8GWh/day; that is 2920 GWH/year, which is more than the energy generated from the Nepal Electricity Authority (NEA) owned power stations in the year 2008/09 (i.e.1839.5GWh). However, recently the Alternative Energy Promotion Centre's (AEPC) report on Solar and Wind Energy Resource Assessment in Nepal (SWERA) stated that the commercial potential of solar power for grid connection is only 2100 MW (Current status of renewable energy in Nepal Surendra K.C. Samir Kumar Khanal, Prachand Shrestha, Buddhi Lamsal, 2011)

The solar photovoltaic system is emerging as an alternative energy source not only for rural household lighting but also for commercial purposes. With development of proper institutional setup, effective dissemination and involvement of government and donor agencies solar PV technology could make significant contribution in meeting rural energy needs for decentralized rural electrification (CADEC, 2003)

Nowadays there is high priority for development, use and promotion of clean energy, which can be easily available, economically affordable and environmentally sustainable, and the solar energy is one of them. The development of this solar energy will cut imported commercial fuel and help to reduce the trade deficit, help to tackle environmental problems like global warming, climate change etc, so social research studies are to be carried out in this arena which will eventually help rural propel to increase their access to light, access to energy and leads to achieve higher standard of living.

1.3 Research Objectives

The general objective of the study is to find out the socio-economic of impact of Solar Home System in Maharudra VDC of Baitadi district and to edit prospects of using Solar Home System (SHS) in terms of energy access and their per capita consumption and it's the socio-economic benefits to the rural community.

The specific objectives of the study are:

-) To analyze the energy scenario and assess the per capita energy consumption of the study area.
-) To assess the socio-economic impact on SHS installed households.
-) To examine the knowledge and attitudes towards SHS.

1.4 Rationale of the Study

SHS is the reliable source of energy especially for lighting. It not only protects the ecological environment but also adds new scenario to the spots that ease the lives of rural people. The potential for Solar PV technology is obvious in those rural areas where extension of grid electricity may be techno-economically not feasible. This obviously invites for SHS installation.

About 83% of the total population still lives in rural areas of Nepal. Only 30% of rural people have electricity access, so kerosene is the most common source of lighting in rural areas. Dry cells are used to power radios and torch lights. An effort has been made to replace the kerosene lamps with efficient, cost effective, reliable and environmentally friendly SHS based torch lights. It also helps to improve child education due to increased study hours.

On economic point of view, SHS installation has not just helped to save Kerosene, battery etc, but also opens up new income generating opportunities in rural areas like weaving, photography, running telephone, Thangka painting etc.

Solar PV home system is only option for the rural electrification where due to various reasons such as diverse geology/structure of land form, the scattered settlement, electricity from national grid is not feasible and costly. Running big hydroelectricity requires huge investment and long duration of time, in this context Solar PV Home System is highly suitable which also contribute, in a small way, to control the migration of people from rural to urban areas in search of better way of life and for other facilities. Solar energy is less costly than micro hydropower and other electricity and can be easily carried out from one place to other.

The study is very important for understanding and identifying the changes in the status, way of living and activities of SHS user household in the study area. Assessment of the impacts of SHS users, their activities, their capacities and

understanding on utilization of SHS will certainly be helpful in forming Clean Development Mechanism (CDM). The outcomes of the study will be of great importance to policy makers to formulate appropriate plan for further development of the appropriate technology that better suits the rural people needs from each and every aspects.

1.5 Limitations of the Study

The scope of the study is to state, stimulate and explore the prospects, problems and implications of SHS in the rural sector. As everything has its own pros and cons, the limitation that our study consists of:

1. The study is mainly confined to Maharudra VDC of Baitadi district of Nepal. Thus, generalization of the conclusion derived from the study in national/international level may not be relevant to others.
2. The study is very specific case study. It only deals the importance of SHS in Maharudra VDC.
3. The study is limited in terms of deeper analysis as only a few variables selected from the numerous factor affecting the solar energy consumption in the study area.
4. This study is limited to the socio-economic, energy, communication as well as educational aspects.
5. Our research being descriptive, we more conveniently use observation, Questionnaire and interview. The information provided by different households may have limited accuracy that is observed during survey activities.

1.6 Organization of the Study

The study in total consists of six chapters. The first chapter includes introductory information about study and study objectives i.e. background, statement of the problem, objective of the study, rationale and limitation of the study.

In second chapter reviews of literature is included. The third chapter describes the methodology adopted for the study i.e. research design, rationale of the study area, sampling procedure, data collection techniques and tools.

Data presentation and analysis of the study has been organized in chapter four while discussion on energy scenario, socio economic and other various impacts of SHS has been made in chapter five. Major findings, conclusions and recommendation are incorporated in chapter six.

CHAPTER-TWO

LITERATURE REVIEW

Any study on renewable energy sources like solar energy is primarily a challenging job in a sense that it requires a wide range of literature during the work. Literature review gives many information and knowledge about the concerned study field which will be very fruitful guidance to the new researcher to make the study systematic, scientific, objective oriented so it is the backbone of the study. In the context of modern solar energy technology in Nepal it is still in its fledging stage, so there is no wider scale. Adequate study on impact assessment of solar home system in the rural areas though some government, non-government and private organization has carried out some research. In this chapter, an attempt has been made to review the information available on these systems under following headings.

2.1 Solar Energy Resources in Nepal

Solar energy was first conceived as a viable alternative form of power as early as in the 1860s when coal was expected to be running out of supply .The global oil crisis of 1973 brought renewed attention to the potential of solar power as alternative source of energy

Nepal, being located in favourable latitude, receives ample solar radiation. The average solar radiation varies from 3.6–6.2 kWh/m²/day, and the sun shines for about 300 days a year. The development of solar energy technology is thus reasonably favourable in many parts of the country. As per the recently published report of AEPC, 2008 under Solar & Wind Energy Resource Assessment in Nepal (SWERA), the commercial potential of solar power for grid connection is 2,100 MW. With National average sunshine hours of 6.8/day and solar insolation intensity of about 4.7kWh/m²/day, there is a huge potential for development and promotion of Solar Home System in Nepal.

For 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 around the fairly cold high altitudes or in the mountains and would be difficult to achieve with roving herds of cattle .Small Hydro turbines need specific topographical conditions that are only found near a small percentage of users' dwellings. Solar electricity generating systems, do not need fuel or extensive infrastructure, are easy and quick to install and thus could be very attractive option in rural parts of the country. However, it cannot be claimed that solar electricity can solve rural electrification issues completely. Solar electricity too has limitations and problems but these can overcome with proper planning.

The solar electricity potential:

The country has 300 sunny days per annum and thus is very rich in solar power potential. Using PV module of 12% efficiency, total energy generated will be $0.12 * 4.5 * 147,181 * 10^6 = 80,000 \text{ GWh/day} = 17.7 \text{ TW}$ (assuming peak sun to be 4.5 hours). This energy generated is more than energy required for fulfilling the whole energy demand of the world. The total estimated world energy demand at present is about 13 TW. If we use just 0.01% of the total area of Nepal, we can generate solar electricity of 8 GWh/day that is 2920 GWh/year (which is more than the energy generated by NEA in the year 2003 amounting 2261 GWh/year) (WECS, Energy Sector Synopsis Report 2010)

In Nepal, subsidy is provided to solar home systems in areas without electricity. In such areas, people derive their livelihood mainly from agriculture. Besides agriculture, people's source of income may be small business or sale of handicraft, all of which are labor intensive activities. In such context, SHS may increase the time available to work by allowing people to engage in economic activities even at night (AEPC/DANIDA: 1999).

Electricity provides light that is hundreds of times bright and at the same time cheaper than kerosene based lighting. Lighting with electricity allows business to extend well, which has potential of income and employment growth. It also enables women to engage in productive activities. (Power and People: The world Bank 2010).

“Electricity lighting may also increase study hours for school going children, increase their educational achievements” (Barnes, Perkin and Fitzgerald; 2003; Kulkarni and Barnes 2004)

Result shows that those households who opt to install SHSs have higher landholding, income (increase probability of initiating business by 3 times) and awareness. Education is another sector where SHS has had significant impact. Students with Solar Home System are 1 hour more likely to study every day than without SHS. Surprisingly, findings show that there is no impact of SHS on health outcomes.

2.2 Meaning and Definition of SHS

Solar PV Home System is the system in which the energy from sunlight is converted into electricity. It is the household electricity supply system with Solar Photo Voltaic panel of capacity of 5Wp to 10 WP and more, and bundled with battery, battery charge controlling mechanism and appropriate number of lights.”

Solar Home System (SHS) is defined as the household electricity supply system with solar photovoltaic panel of capacity 10Wp or more and connected with battery, charge controller and appropriate number of DC lights” (AEPC, 2006)

Photovoltaic’s is civilized alternative that respects human values and does not promote predatory attitudes which leads to conflicts over energy resources” (Sao Paulo Declaration 1991)

The module, the basic building block of the systems consists of a numbers of solar cells electrically interconnected and encapsulated within a supporting structure. Solar cells usually in the form of thin films or wafers are semiconductor device(usually made up of Crystalline silicon) that converts 3-14% of the incident solar energy to DC electricity with efficiencies depending on illumination, spectrum intensity, solar cell design, material and temperatures. The modules are available in sizes from 20-50watts. Large power outputs from a single source can be obtained by combining modules. At present two types of systems are commercially available in the mountain areas they are:

- A) Centralized SPV power station
- B) Standalone system or commonly known as Solar Home System (SHS)
(10-120 watts)

Centralized SPV power station can provide grid electricity by converting DC power generated from solar cells to AC. This system can provide lighting and other small

scale power applications for the remote and isolated mountain areas. A SHS (40W) provides DC electricity to power 3 or 4 lights and a radio or TV for 3 or 4 hours per day .In most of the mountains areas SHSs are more popular than centralized SPV power plant, as most of the centralized system installed during late 80's didn't function properly due to the operation, repair and maintenance problems primarily relating to DC-AC inverter. (www.hlf.org.np)

Several wattages such as 10W, 20W, 36W, 40W, 50W, 60W, 75W and 100W of SHS are mostly available.

A 36WP SHS comprises of a 36W panel (solar PV module) with a current rating of 2.2 ampere, and which is used to charge the battery through the charge controller during the day time. So the charged stored in the battery during the daytime can be used to light the energy efficient lights during the night time (Lotus Energy Eke Chinari, 2006)

How a solar-home-system works?

When the sunlight falls on the surface of the panel (modules) the electrons get excited and start moving in the metal stripes of the panels. When flow is high (i.e. peak sun or more than average sun) the potential is built up and then since the two terminals of the panel is connected to the terminal of battery (negative and positive) via charge controller, the electrons or the charge get stored in the battery, which in turn can be used in the night time when there no sun light (Sharma, 2003).

Photovoltaic (PV) modules use semiconductor materials to generate D.C. electricity from sunlight. A large area is needed to collect as much sunlight as possible, so the semiconductor is either made into thin, flat, crystalline cells, or deposited as a very thin continuous layer onto a support material. The semiconductor must be sealed into a weatherproof casing, with suitable electrical connectors.

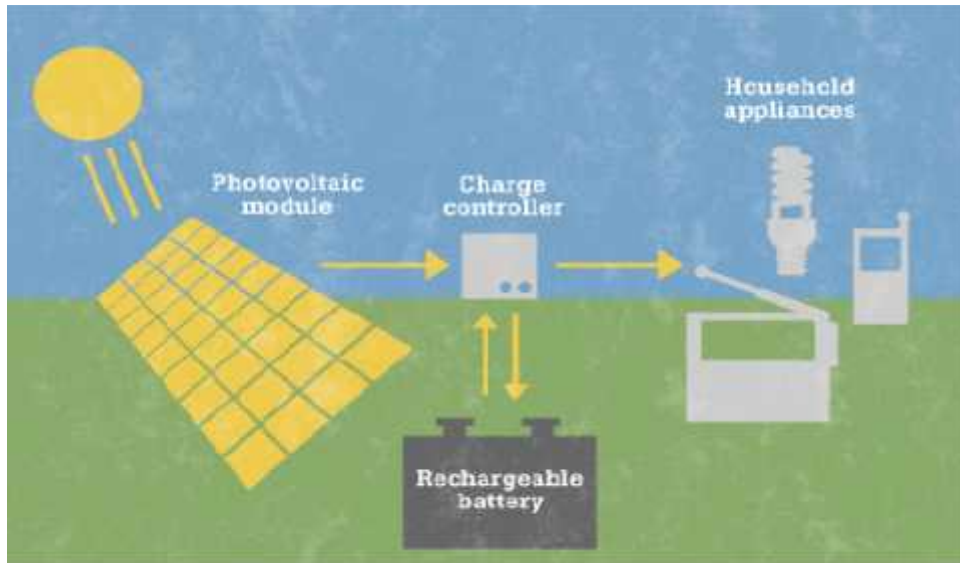


Fig 2.1: Layout of a Solar-Home-System

PV modules are specified by their ‘watt-peak’ (WP) rating, which is the power generated under standard conditions, equivalent to bright sun in the tropics (they still work at lower light levels though). Most solar-home-systems use modules between about 10 WP and 100 WP rating.

The rechargeable batteries store spare electricity on sunny days, so that it is available at night and on cloudy days. They also provide a stable voltage (usually 12 V) for the devices which use the electricity. Standard lead-acid car batteries can be used, but they don’t last long if they are heavily discharged, so specially-made solar versions are strongly recommended. Other types of rechargeable battery like nickel-cadmium and nickel-metal-hydride are increasingly used, particularly in small systems like solar lanterns. They are more expensive, but easier to make small and portable, and more tolerant of being heavily discharged.

All equipment run directly from the PV supply must be designed for 12 V/ D.C. operations. Efficient lights and appliances make best use of the limited supply of electricity. Efficient D.C. fluorescent lights are available down to about 3 or 4 W power rating, in both tube and compact forms. LED lights are even more efficient, and are now sufficiently cheap and reliable to be used as well. In most systems, an electronic charge-controller is used to protect the battery from being overcharged (when it is very sunny) or over-discharged (when people try to get too much

electricity from the system). The charge controller usually has lights or a meter to indicate the state-of-charge of the battery. (Wikipedia)

2.3 History of PV Technology

-) 1839AD Edmund Becquerel, the French experimental physicist discovered the photovoltaic effect.
-) 1875- William Adams and R.day discovered that the junctions of Selenium and platinum also exhibit photovoltaic effect.
-) 1877- The first Selenium solar cell was constructed.
-) 1904 - Albert Einstein provided the theoretical explanation to photovoltaic effect.
-) 1918 - Polish scientist Czohralski discovered the method for mono crystalline silicon solar cell.
-) 1941 - The first silicon mono crystalline solar cell was constructed.
-) 1955 – Hoffman electronics semiconductor division produced the first commercial PV with 2% efficiency.
-) 1958 – The efficiency of the solar cell was increased to 9%.
-) 1958 – The first PV powered artificial satellite of Earth, Vanguard I, with 0.1W solar cell occupying an area of approximately 100cm sq and powering a 5MW back up transmitter was launched. Three more PV satellite was launched in the same year.
-) 1963- Sharp company became the first company to develop the first usable PV module.
-) 1974 – The cost of PV power dropped down to US\$30/watt from US\$ 1,785/watt
-) 1980 – ACRO Solar became the first manufacturer to produce PV modules with peak power of 1 MW
-) 1983 – Worldwide production of PV modules exceeds 21.3MW with a business volume of 250 Millions US\$.
-) 1999 – Total installed capacity of PV, modules exceeded 1,000 MW worldwide.
-) 2002 – Total installed capacity of PV power exceeds 2000 MW of business volume of about 2 billion US\$. (www.energyhimalya.com)

2.4 History of SPV in Nepal

There is no exact evidence on when solar PV was first time used in Nepal but it is said:

-) First PV module was used in 1963 in Bhadrapur Airport for navigation purpose (Shrestha, 1998).
-) 1974 AD Nepal Telecom (NTC) used solar PV power to operate a high frequency transceiver located in Damauli.
-) 1980 NTC started massive use of solar PV power. It has remained as the largest corporate users of PV total installed capacity exceeding 10,000KWp.
-) 1987 ADB/N was using solar PV power to electrify its 100 branch offices.
-) 1988 Centralized electricity supply from PV started. Nepal Electricity Authority (NEA) with the assistance of French government installed centralized solar PV power system in Simikot (50 KWP).
-) 1986/87 Use of solar PV technology to lift water for drinking and irrigation purposes.
-) 1989 NEA installed another centralized solar PV power system in Kodari/Tatopani (30KWP) and Gamgadhi (50KWP) of Mugu district.
-) 1991/92 Recorded use of solar PV power for domestic electrification, with the effort of government of Nepal with financial support of France in Kodari, Tatopani, simikot and Gamgadhi. The outcome proved failure as it was not a household based solar electricity system. Solar electricity was distributed from central station, a numbers of unforeseen technical and community mobilization problems cropped up (REDP, 1997).
-) 1993 Successful launching of Pulimarang village (Tnnahu district) electrification project by Center for Renewable Energy (CRE) with the support from Solar Energy Light Funds (SELF), USA and Pulimarang community support. During the first phase 46 SHS were installed after this use of PV for the rural electrification gained the momentum in valleys.

-) 1993/94 Solar PV system has also been used by numbers of health post, schools in rural areas for lighting, operating vaccine refrigerator.
-) 1995 The first highly subsidized (95%) 68 SHS were installed at Chhaimale village in southern part of the Kathmandu by Wisdom Light Groups PVT.Ltd.
-) 1996 ADB/N provided 50% subsidy to install 40SHS at six VDCs in Kavreplanchowk district for the first time in Nepal. (Kayastha, 2000)
-) 1996 The Government of Nepal established the Alternative Energy Promotion Centre (AEPC) to look after all RETs. It is National Executing Agency for RE programs and projects. It is under Ministry of Environment and has semi autonomous status. It has mandate for policy & plan formulation, resource mobilization, coordination, quality assurance and Monitoring of RETs
-) 2000 In October government announced renewable energy subsidy policy. Accordingly, subsidy will be provided to SHS of 10-120Watt peak (AEPC, 2000).

2.5 Periodic plans for Solar Energy

2.5.1 Five Year Development Plans

The Seventh Five Year Plan (1985-90) was the first of national policies to address Renewable Energy Technologies (RETs). The Plan recognized that RETs could replace traditional sources of fuel in rural areas and sought to encourage the development and adoption of alternative sources of energy like biogas, solar and wind. Later AEPC drafted the 20 Yrs RE Perspective Plan in 2000. The plan envisioned for the government to provide subsidy for the use of solar energy, to make solar technologies meet rigorous standards, to give NGOs and the private sector a prominent role in the development and promotion of solar energy, and to support research and development activities.

During the Eighth Plan (1992-97), Alternative Energy Promotion Center was established in 1996 under then Ministry of Science, and Technology with the objective of promoting and coordinating activities and programs at the national level. This was an important development that created a central authority that could

formulate and enact policies related to renewable energy. The Ninth Plan (1997-2002) sought to tie the economic development of rural areas with rural electrification. Solar energy was identified as one of the most appropriate source of electricity in rural areas. Interim Rural Energy Fund (IREF) was set up to administer subsidies for solar PV systems and other RETs. Most importantly, Energy Sector Assistance Program (ESAP) was started during this period.

The Tenth Plan (2002-2007) focused on the use of alternative energy for economic development, sought to accelerate the commercialization of alternative energy technologies and to replace traditional sources of energy by modern and renewable sources. As planned, IREF was transformed into Rural Energy Fund (REF) during this period and Rural Energy Policy was promulgated in 2006. Rural Energy Policy (REP) seeks to link renewable energy to economic development and increase the role of local agencies, NGOs, and private sector in its promotion. With respect to solar PV, REP subscribes to increasing the provision of subsidy and linking solar energy to improvements in health education, irrigation, drinking water, and communication.

The Three years Interim Development Plan (2008-2010) has targeted to expand the services of electricity in such a way so as to ensure coverage of an additional 5 percent of the population through alternative energy sources. The interim plan has also identified a lack of coordinated effort for the development of alternative energy sources in order to provide electricity in the rural areas as one of the major challenges in the sector of electricity and power (Status of Solar Photovoltaic in Nepal, AEPC 2010)

2.5.2 Perspective Energy Plan

The national planning commission prepared the Perspective Energy Plan (1991-2017). The plan has made a number of recommendations for the development of solar energy. The recommendations made are as follows:

- a) Provide government subsidy for a definite period of time, say 10 years
- b) Standardize solar technologies and ensure strict quality control.
- c) Give the lead role to NGOs and private sector and the facilitating role to the government.

- d) Support R & D activities in respect to water heating, cooking and cost reduction of solar PV system

2.5.3 Solar PV in National Energy Policies

Solar PV has found its place in following two policies of the Government of Nepal.

1. Rural Energy Policy, 2006
2. Subsidy Policy for Renewable (Rural Energy), 2009 promotion.

2.5.4 Rural Energy Policy, 2006

With an overall goal to contribute to rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in the rural areas, the Government of Nepal has promulgated “Rural Energy Policy 2006” with the following objectives:

- i) To reduce dependency on traditional energy and conserve the environment by increasing access to clean and cost effective energy in the rural areas.
- ii) To increase employment and productivity through the development of rural energy resources.
- iii) To increase the living standards of the rural population by integrating rural energy with social and economic activities.

2.5.5 Subsidy Policy for Renewable (Rural) Energy 2009

I) Solar Home System

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 areas.

Table no: 2.1

Subsidy Policy for Renewable (Rural) Energy

Geographical 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 categorized C	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.

In order to provide quick relief from kerosene tuki and jharro etc. in the rural areas, a small solar PV system based on White LED will be promoted. A subsidy of NPR 2,000 per system will be provided to a SSHS consisting of at least 5Wp solar panel along with two sets of solar lamp.

ii) Institutional Solar PV System

1. The subsidy for Solar PV systems used by public institutions such as for operating computers in remote schools, vaccine refrigerators in remote health posts, FM radio equipments in remote areas and remote Tele-centers etc. will be up to 75% of the cost of installation.
2. The subsidy amount of 75% not exceeding NPR15,000 will be provided for PV systems used in lighting for monasteries, temples, churches, mosques and other religious places in the remote area without electrification by any other means.

The objectives of the new subsidy policy 2013 will be as follows:

- To increase the access to the renewable energy technologies to low

- income households by reducing the initial upfront cost.
- To maximize the service delivery and its efficiency in the use of renewable energy resources and technologies in the rural areas, and to provide opportunity to poor and socially disadvantaged rural households to use renewable energy solutions and minimize regional disparity.
 - To support use of energy for productive purpose thereby creating rural employment and enhancing livelihood of rural people particularly women, poor and socially excluded group, vulnerable community through increasing their access to renewable energy.
 - To support rural electrification as well as gradually reduce the growing gap of electricity supply, consumption between rural and urban areas.
 - To support development and extension of renewable energy market by attracting private sector entrepreneurs.
 - To support to the envisaged long-term targets of Government in providing rural electrification and energy services.
 - To encourage rural households in the use of renewable energy services thereby contributing to better health and education conditions of people.

Subsidy Type and Level

The Category “A” Village Development Committees, Category “B” Village Development Committees, and Category “C” Village Development Committees (herein after called Category “A” VDCs, Category “B” VDCs, and Category “C” VDCs respectively) means very remote VDCs, remote VDCs, and accessible VDCs as mentioned in Annex 1 for the purpose of the subsidy amount as defined by the Government of Nepal. While designing the subsidy rate, the basis of around 40% of the total cost will be covered by subsidy, around 40% by the soft loan from the financial institutions, and rest minimum of 20% by the community or households in kind and cash

Solar PV Systems

Subsidy for solar PV home systems will be as follows:

Solar PV Systems	Subsidy Amount in Rs.		
	Category "A"	Category	Category
	VDCs	"B" VDCs	"C" VDCs
Small Solar Home System with 10			
Watt Peak (per HH per system)	5,000	4,800	4,500
20 Watt Peak - 50 Watt Peak Solar			
PV System (per HH per system)	7,000	6,200	6,000
> 50 Watt Peak Solar PV System (per			
HH per system)	10,000	9,000	8,000

- The maximum subsidy amount of 75% of the total systems cost but not exceeding Rs. 1000,000 will be provided for solar photovoltaic system to be installed in public institutions like school, health post. If the system is used only for lighting purpose in religious place, subsidy amount will be same as the SHS.
- The subsidy for the PV pumping system for drinking water to be managed by community will be provided up to 75% of the total system cost but not exceeding Rs. 1500,000 per system. The additional subsidy of Rs. 2500 per household will be provided to household with single woman, backward, disaster victim, poor, and endangered ethnic group as identified by the Government of Nepal.
- The Ministry will prepare the guideline for the management of the lead acid battery to be used in solar energy.

2.6 Current Status of Nepal's Solar Projects:

2.6.1 Energy Sector Assistance Program

Started in 1999 supported by Denmark, Norway, KfW/Germany and DFID/UK.ESAP phase I planned to install approximately 25,000SHS and a number of community based institutional systems equivalent to more than 0.8MW by the year 2003/04 on a demand driven basis. The result is that the ESAP I phases exceeds its target. It has caused by Nov.2006 to have installed more than 70,000SHS in Nepal. A total of 229, 7971 SHS have been installed till the second week of December, 2010 and the trend is in increasing numbers.

2.6.2 Renewable energy project

Started in 2003 will end in beginning of 2012, Supported by European Commission.

Major technologies/Programs are Institutional Solar PV for computer in school, Operation of refrigerator in health post, pumping of drinking water, Community dryer, solar hot water systems etc.

2.7 Major Users of Solar Electricity in Nepal

First officially recorded use of solar electricity in Nepal is not known. But it is said that the Nepal Telecommunications 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 one of the significant users of solar electricity amounting to more than 1000KWP generating about 47000 kWh/day of electrical energy at more than 3000 locations, without national grid supplied electricity. Seventy five percent of all the Public Call Offices (PCO) in

NTC are being powered by PV. The estimated market potential is huge and about 5 MWP of photovoltaic power is currently being used in various public and private sectors (telecommunication, utility supply, stand-alone, water supply, aviation etc.) in Nepal are shown in table below:

Table No: 2.3**Application of PV Power by Sector (until 2005)**

S. No	Service	PV Power, KWP	% Power	No. of Installation
1	Telecommunications	1001	21.6	3000+
2	Utility supply (centralized)	100	2.1	2
3	Stand-alone system	3328	71.8	75000+
4	Water supply	93	2.0	25
5	Aviation	37	0.8	45
6	Miscellaneous	78	1.7	100+
	Total	4636	100	

Stand-alone Solar Home System (SHS) constitute above 5000 kWp with 185017 numbers as of until 2008/09. The trend of SHS installation shows a steep rise after 2000 due to the subsidy policy implemented by AEPC/ESAP. Till December 2004, 51 solar PV pumping systems have been installed, of which 28 were installed after 2000 with subsidy provided from AEPC. (WCES, 2010)

2.8 Yearly Installation of Solar Home System in Nepal**Table no: 2.4**

S.N.	Fiscal Year	District Total No	Capacity	(Wp)	MW
1	Up to 056/57		11758	442652	0.44
2	057/58	35	6211	242064	0.24
3	058/59	63	13745	543486	0.54
4	059/60	65	18482	650669	0.65
5	060/61	71	15106	411095	0.41
6	061/62	67	17887	462679	0.46
7	062/63	67	6788	175052	0.18
8	063/64	61	6690	167113	0.17
9	064/65	68	34755	822964	0.82
10	065/66	73	53595	1249430	1.25
Total			185017	5167204	5.17

Source: AEPC (2010)

2.9 Total Energy Consumption by Fuel Types (2008/09)

Table no: 2.5

Types	Ag residue	Animal dung	Fuel wood	Petroleum	Coal	Electricity	Biogas	Micro hydro	Solar
%	3.7	5.7	77.7	8.2	1.9	2.0	0.6	0.01	0.0001

Total Consumption 401 Million GJ (WCES 2010)

2.10 Number of Households by Usual Type of Fuel Used for cooking.

Table No: 2.6

Area/sources	Firewood	Kerosene	LPG	Cow dung	Bio-gas	Electricity	Others	Not stated	Total
Nepal	3,470,224	55,610	1,140,662	563,126	131,596	4,523	22,583	34,973	5,423,297
Urban	268,643	20,990	707,674	15,776	19,121	1,255	4,107	8,009	1,045,575
Rural	3,201,581	34,620	432,988	547,350	112,475	3,268	18,476	26,964	4,377,722

(Source: Nepal Population and housing Survey, 2011)

2.11 Number of Households by usual source of lighting

Table No: 2.7

Area/sources	Electricity	Kerosene	Bio-gas	Solar	Others	Not stated	Total
Nepal	3,647,746	991,510	15,264	403,504	330,170	35,103	5,423,297
Urban	983,995	42,297	3,671	2,082	5,438	8,092	1,045,575
Rural	2,663,751	949,213	11,593	401,422	324,732	27,011	4,377,722

(Source: Nepal Census, 2011)

2.12 Population aged 5 years and above by literacy

Table no 2.8

Area/Sex	Pop aged 5 years and above	Can read and write	Can read only	Can't read and write	Not stated
Male	11,534,084	8,666,282	283,708	2,575,935	8,159
Female	12,392,457	7,111,504	319,069	4,948,492	13,392
Total	23,926,541	15,777,786	602,777	7,524,427	21,551

(Source: Nepal census, 2011)

CHAPTER-THREE

RESEARCH DESIGN AND METHODOLOGY

Methodology is the backbone of the study. So, it needs to be well defined to conduct the study. Therefore in this study the following methodology has been adopted to fulfill the objectives.

3.1 Research Design

It is the blueprint for the collection of data. It is a work plan owing to the objective of the research. For this study, a descriptive and exploratory research design was followed. The purpose of the study is to describe the socio-economic impact made by the use of SHS in the household level of Maharudra VDC of Baitadi district. The descriptive method was used for the qualitative data obtained during the study. The data's that are not quantifiable was explained literally. On the other hand I had analyzed and discover degree of interdependence between various characteristics/ activities that are influenced by SHSs in such cases the exploratory research design has been used. I have also looked into the problem by exploring the views of different set of respondents, as well as by exploring different literatures related with the study.

3.2 Rationale of the Selection of Study Area

Since last decade SHS has emerged as an important source of alternative energy in Maharudra VDC of Baitadi district. So the present study has been carried out in Maharudra VDC of Baitadi district which lies in Far Western Development Region of Nepal.

The reason to select Maharudra VDC is that there are no other reliable sources of energy except solar, kerosene and fuelwood. The researcher himself is the local inhabitant of the same district, so he is familiar with the local culture and practices.

All in all the researcher was well convinced that by the selection of this VDC, it could get more accurate information to fulfill his objectives easily and effectively under any circumstance than any other study area.

3.3 Nature and Sources of Data Collection:

Data is a set of fact, sheets the wholesome aggregate of which gives the information. This information in fact contributes to the inquiry of truth and approaches towards the reality. Both primary and secondary data were used in this study. Data gathered are both qualitative and quantitative in their nature.

3.3.1 Primary Data

In the due course of my research, primary data were collected viz. observation, interview, and through structured and semi structured questionnaire as per the convenience to aid to the study. Used sets of questionnaire are attached in the Annex I. Questionnaire was the main tool for collecting information in the field survey.

3.3.2 Secondary Data

Since, this research is mounted on the base of description and analysis, secondary data plays the vital role. The various internal and external sources were used for acquiring the secondary data. The various sources consist of:-

-) Village Development Committee
-) Central Bureau of statistics
-) Alternative Energy Promotion Centre
-) Various Solar Home System providing companies
-) Google
-) Bulletins/reports
-) District Rural Energy Programme, etc

3.4 Quantitative and Qualitative Research

Since, this research was more concentrated towards the prospects of SHS in rural area of Nepal i.e. Maharudra VDC of Baitadi district, the degree and depth of impact of SHS is different in different aspects of rural livelihood was studied. On this regard quantitative research was carried out. It is because it helps to analyze the calculated information with the standard normative values and helps in comparisons. The attitude, awareness and perception of various stakeholders- SHS users were studied through qualitative research method. However, every information cannot be

quantified nor all the data can be interpreted quantitatively so various elements was interpreted in qualitative nature.

3.5 Universe and Sampling

The total installed SHS under government subsidy in Maharudra VDC of Baitadi district is 50 HHs so there was only 40 SHS operating HHs in the VDC. Total population of Maharudra VDC is 4080 having male 1871 and 2209 female populations with total 712 households (National Population and Housing Census, 2011).

In this study, out of total 712 households of the Maharudra VDC, these all 40 households who are the users of Solar Home System were taken as sample households as purposive sampling. For the study related to socio-economic impact of SHS and energy, 10 more households who were the non-users of SHS was chosen by simple random sampling method. So total sample households including both SHS users and non- users is 50. Approximately each ward has average 79 households. Out of total 50 sample HHs, 35 sample households belongs to ward no. 1, 15 sample HHs belongs to ward no. 2 and 3.

The prepared the questionnaire includes both type i.e. open ended and close ended in order to acquire reliable information by making the respondent comfortable and ease to provide the information.

3.6 Techniques and Tools of Data collection

This research has been conducted by employing various methods for data collection. Both primary and secondary data has been collected. The researcher himself collects the primary data from the respondents by conducting the questionnaire survey with the SHS users. For the collection of primary data following data collection techniques were adopted:

3.6.1 Households Survey

The name list of the household head was obtained directly through visit and house to house survey was conducted. The questionnaire forms were filled up by the researcher

interviewing with household heads. In the absence of household head, another senior person present at the home was taken as the respondent.

3.6.2 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, the probable remedies were observed. The data's were collected observing the households environment, solar home system wiring, condition of panel, elevation of panel setup, battery conditions, types of bulbs etc were closely monitored by the researcher.

3.6.3 Key Informant Interview

A Key Informant Interview is loosely structured conversations with the people who have specialized knowledge about the topic. To dig out its major key informant's interview were conducted within the study area. The key informants were Teacher, local political leader, VDC staffs, Businessman and Local SHS technician. By interviewing them on the basis of prepared set of questionnaire allowing the respondents enough leeway to provide the information, the information was recorded.

3.7 Data Processing and Analysis

The collected raw data can be molded as per the requirement and objectives of the research. The various steps that are were followed are

3.7.1. Data Processing:

- a. Editing: The collected raw data were edited to detect error and omissions. So to overcome the possible error in our research editing was done carefully.
- b. Coding: In order to make the research more systematic and scientific, assigning of numerals or symbols to answer has been carried out, so that it helped to allocate the answer whenever necessary.

- c. Classification: The result of research study is at large volume in the form of raw data. So in order to simplify it has been classified into homogeneous groups, so a meaningful relationship can be profoundly studied.
- d. Tabulation: After the necessary classification of data the next step taken was arranging the data in respective tables/ charts. The tabulation is essential in order to systematize and logical arrangement of data for further manipulation.

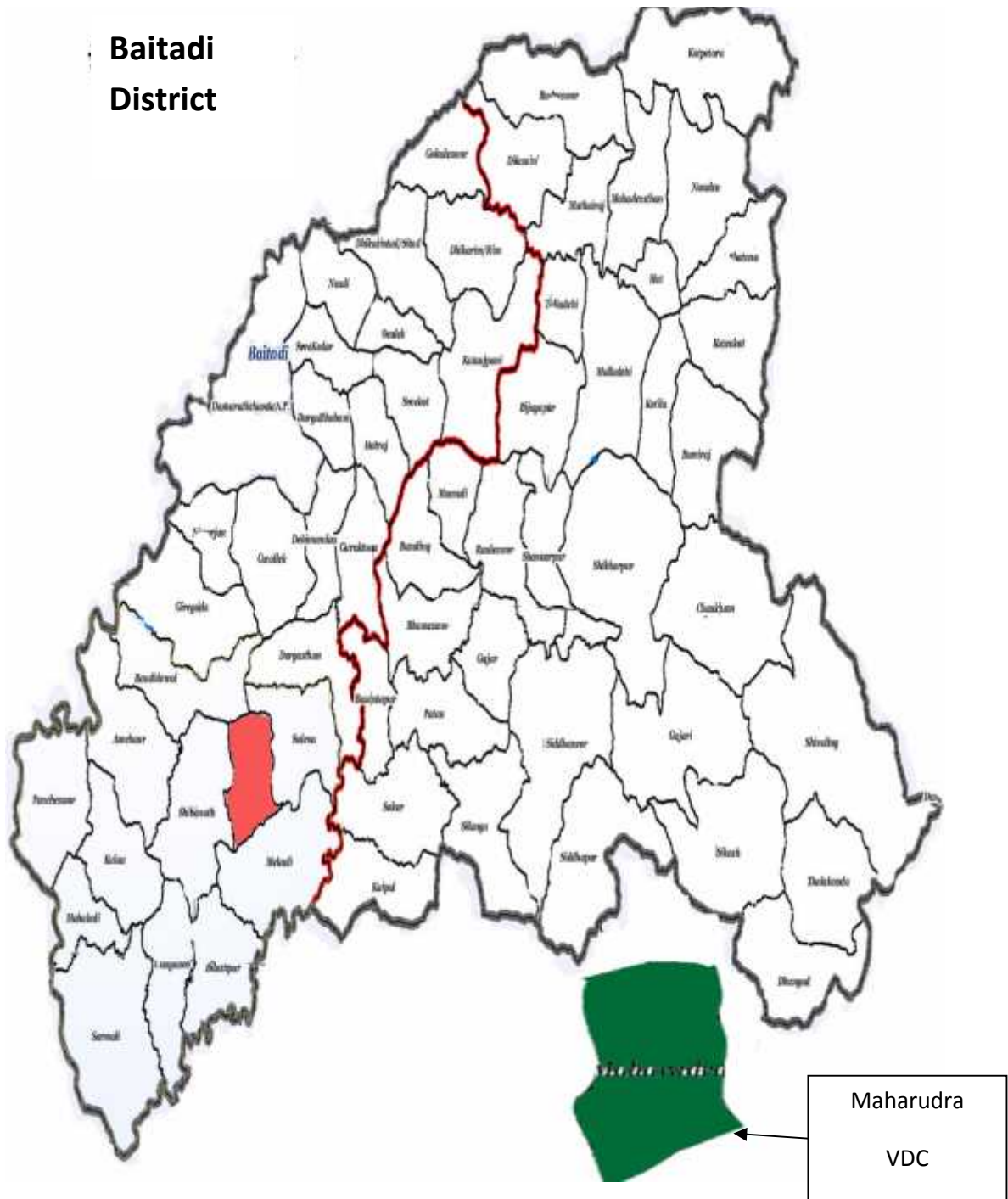
3.7.2 Data Analysis:

All the data's has been analyzed systematically and scientifically by using different statistical tools. Primary data has been analyzed according to its nature, so as to address the objectives of the study. Quantitative data has been analyzed using simple statistical tools like frequency and percentage distribution. Qualitative data has been analyzed descriptively and to the extent possible with use of tables and frequency distribution.

Map of Nepal



Baitadi District



CHAPTER- FOUR

DATA PRESENTATION AND ANALYSIS

This chapter attempts to analyze the collected data and information from the field survey and various sources in response to meet the objectives of the study and to derive the major findings of the study. Firstly it includes the brief introduction of Baitadi district and Maharudra VDC regarding its demographic, socio-cultural, economic, geological, political and other aspects.

4.1 Study Area

4.1.1 Baitadi District

Baitadi district lies in the Mahakali zone of Farwestern Developmental Region with its headquarter at Gadi/Gothalapani. It is located at 29°19' to 29°41' Northern longitude and from 81°15' to 80°54' Eastern latitude. Its total area is 1451.13 sq km and its altitude varies from 390m to 2950m. It is at a distance of 849 km from Kathmandu. It shares its boundaries with Bajhang and Doti district in East, Dadeldhura and to South, Darchula to North and Utranchal Pradesh (UP) India in West. There are all together 548wards, 62 VDC, 13 Elikas, 1 Municipality and 2 electoral constituencies. In this district the max. population(7642) is in Sharmali VDC and minimum population (1065) in Haitairaj VDC.

According to National Population and Housing Census 2011, the total population of the district is 2,50,898 with male 117407 and female 1,33,491. The average household size is 5.55 and population density is 165 person/km². The literacy rate of this district is 63% and it's HDI is 0.391. There is total 45,191 households, among which 44,210 HHs use firewood for cooking, 266 HHs use kerosene, 396 HHs uses LPG, cow dung by 43 HHs, biogas by 33 and 3 HHs depends on electricity for cooking & remaining 199 use other sources .

Similarly 11,232 HHs uses electricity as a source of lighting, 17,981 HHs uses kerosene, biogas by 64 HHs and 8,080 HHs use solar as source of lighting. Majority

of population follows Hinduism i.e 99.93% , 0.02 % follows Buddhism, 0.02% follows Christianity.

This district is famous for historical and religious places like Patal Bhumeshwor cave Niglasaini temple, Jagananath temple, Melauli temple ,Guwalek kedar and many more. The Patal Bhumeshwor cave is main attractive place for the tourist and is supposed to be one of the deepest cave of our country. So this area poses high potential for tourism industries since it is very rich in natural resources as well as a storehouse of cultural diversity. The major occupation of people is Agriculture (69%) beside this it is a hub for no. of service industries and various business activities.

4.1.2 Maharudra VDC

The study was undertaken at Maharudra VDC of Baitadi district. This VDC lies in constituency no.2 of Baitadi district. Total area of this VDC is 16.29 sq km. it is at a distance of 12 kosh from the district headquarter. Total population of Maharudra VDC is 4080 having 1871 male and 2209 female populations. There are all together 712 households. (National Population and Housing Census 2011)

Within the VDC, our study is mainly focused in ward no 1, 2 and 3 which is composed of different ethnic groups; largest population in the Maharudra VDC is Brahmin and Chhetri respectively. Besides, the other castes and ethnicities like Chand, Pant, joshi, Dayal, etc, have their considerable presence. The religion of the villagers is only Hindu.

Most of the houses have zinc and slate thatched roofs. The wall of the house is made by mud and stone. The villagers are getting drinking water supply from private and community taps. They get health services from a health post and private clinic.

As far as social organizations are concerned, mainly four types of organizations are found viz. community forestry (Ayar Burauje Samudayik Ban (wadd no1,2,3,4,5 ,Lamakhola Siroda Samudayik Ban, wadd no1,3and 6, Maharudra Salena Samudayik Ban, RaniBan) Mahila Samuha, Political Parties, cooperatives and Schools. There are one higher secondary, one secondary and five primary schools in the VDC. The governmental representation was limited with public schools, health posts and police bits.

Most economic activity revolves around livestock, agriculture, and trade of agro products. The climatic condition is suitable for the horticulture. Most household used to sell fruits, vegetables, milk of cows and buffalos to the local market. No. of households are also found involved in goat farming. Some people are found involved in business and government job, as well as gone abroad for labor.

There was no grid electricity connection till now. Most of the households have been taking significant advantage from Solar Home System. People generally use Firewood as sources of cooking fuel. The kerosene was used for lighting but after Solar was installed it is used as the alternative source of lighting.

4.2 Socio-Economic Characteristics of the SHS Users Groups

4.2.1 Ethnicity/Caste

Ethnicity/caste composition is the components related with socio-cultural aspects. Different ethnic/caste has own culture, practices and needs which significantly affect their energy consumption pattern. The ethnicity/caste composition of the respondent is presented below in table no.4.1

Table No.4.1
Ethnicity/Caste Composition of the Sample HHs

S.NO	Ethnicity/Caste	No. of HHs	Percentage (%)
1	Brahmin	24	48
2	Chhetri	11	22
3	Pujara	2	4
4	Dalit	13	26
	Total	50	100%

Source: Field Survey, 2014

Above table shows that Brahmin are the predominant in installing the solar home system (48%). It is because Brahmins are economically in sound condition and they are elites of that area. Second largest population of Maharudra VDC is Chhetri but Dalit ethnicity has second largest (26%) sharing in installation of SHS among the sample HHS.

4.2.2 Sex and literacy composition of SHS users

The analysis of sex and literacy status of the respondent is one of the important parts of our research. These factors directly and indirectly affect the people's perception, their understanding and behaviors towards the energy consumption. Beside this other social and economic parameters like occupation, income generation etc are also influenced by sex and literacy composition. The sex and literacy composition of the samples is presented below in table no. 4.2

Table No. 4.2
Sex and literacy composition of the respondent HHs

Sex/Literacy	Literate		Illiterate		Total Population()	
	No.	Percentage	No.	Percentage	No.	Percentage
Male	119	76.77	36	23.23	155	47.25
Female	111	64.16	62	35.84	173	52.75
Literacy rate()	230	70.12	98	29.87	328	100

Source: Field Survey, 2014

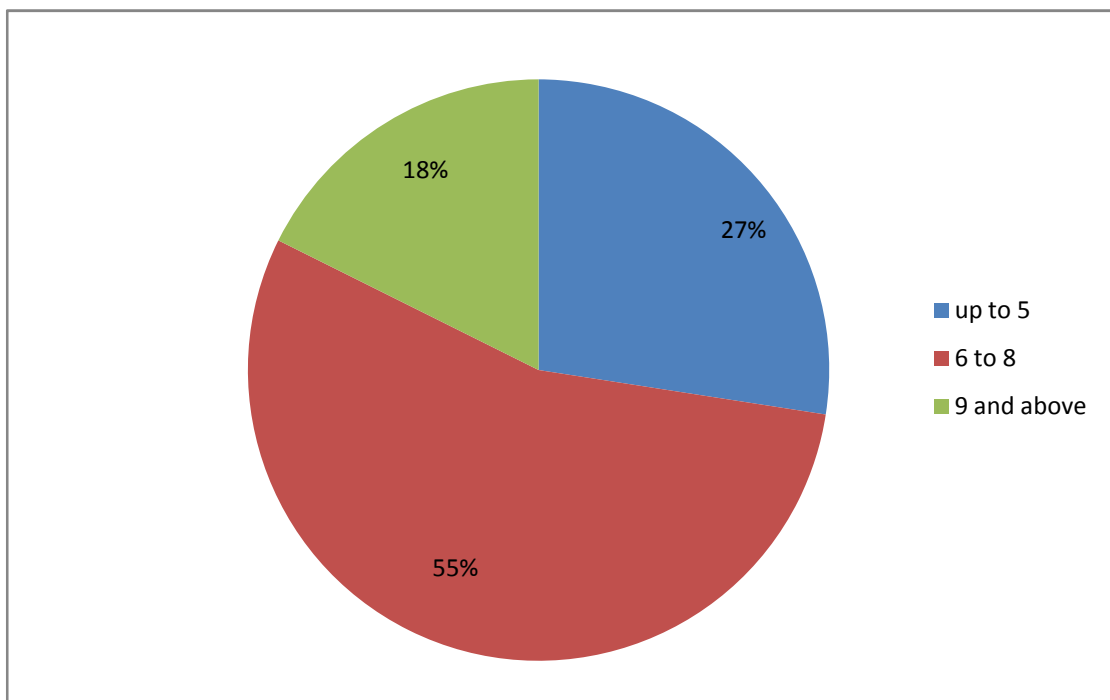
The above table shows that in the study area, the female population is slightly higher (52.75%) than male population,(47.25%).The total population of 50 samples HHs is 328, with average family size 6.56 per household.

In the above table the literacy rate is calculated by taking literacy status of household's members as well as by adding school going male/female as literate in their respective composition. The literacy rate is higher in male (76.77%) than in female (62%). The overall literacy rate of the study area is (70.12%).

4.2.3 Household Size of the Respondents

Different households have different energy needs. It is obvious that higher the household size, higher will be the energy needs and vice versa. Distribution of households according to family size is shown below.

Figure 4.1
Distribution by the Households size of the Respondents



Source:Field Survey, 2014

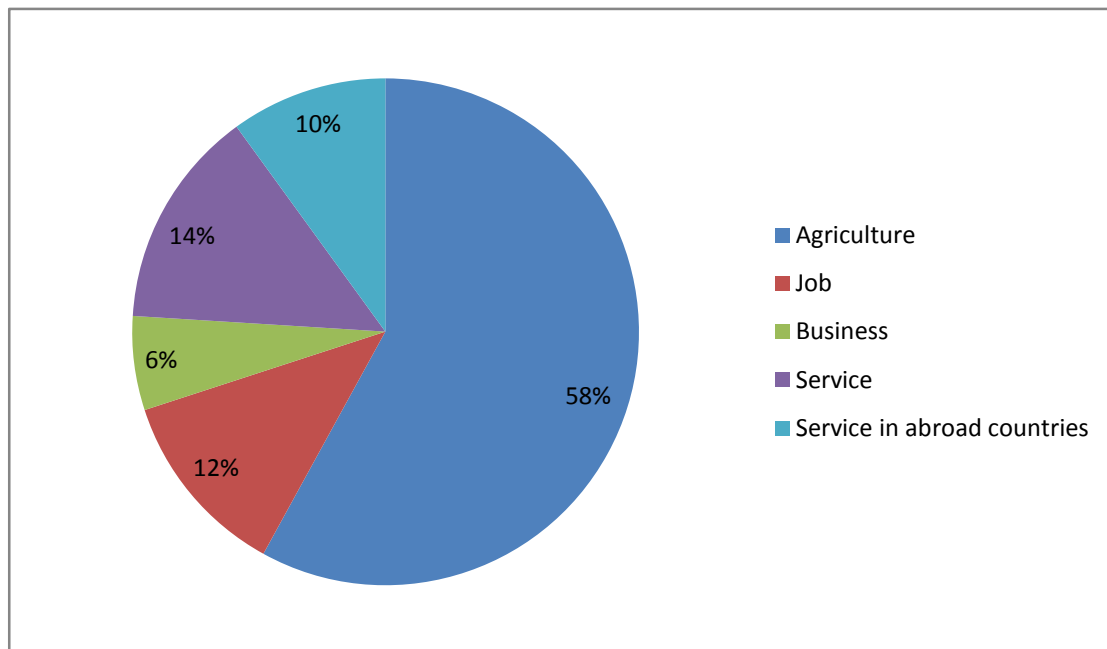
The above figure shows that Highest no.of household(55%) has family size between 6 to 8. Similarly 18% households have family size between 9 and above while (27%) HHs has family size up to 5. The average household size of sample respondents of Maharudra VDC is 6.56.

4.2.4 Occupational Status of the Sample HHs

Occupation is one of the important indicators of the socio- economic status of the people. It also determines the household's wealth, well-being, literacy status and social stigma in society which plays a vital role in the energy consumption pattern. If household has member involved in service, business or in any kind of job they are well known to alternative energy sources like Solar, Bio-gas and they also have caliber to bear the cost of installation. As we know more than (78%) people are engaged in Agriculture in Nepal. People who can fulfill their basic needs by farming are also found during the study forced to adopt SHS to fulfill their energy needs, for their social status, or as imitating. On the basis of major occupation in the study area,

the households engaged in Agriculture, Business, Job, service and service in foreign country has been shown below.

Figure 4.2



Source: Field Survey, 2014

The above pie-chart shows that majority of HHs (58%) are involved in agriculture as their major occupation. It is obvious because people are engaged in agriculture in any way in substantive farming. About (14%) people are involved in service like priest, Tailoring etc. The third largest HHs (12%) are involved in job since there are no of government schools in Maharudra VDC. About (6%) people are involved in business like shopkeeper, hotels. About (10%) HHs is in abroad as labor, that's why our economy is dependent in remittance currently. The low productivity and disguised unemployment may be the reason for people that push them to go abroad for labor. So efforts should be made to transfer traditional farming to commercial farming by providing incentives, modern tools and equipments, training to farmers etc so that the productivity increases.

4.2.5 Annual Income Supporting Annual Expenditure of Sample HHs

The income of the households is crucial factor that determines the people's way of living, their socio economic strata etc which directly affect their access and affordability towards basic needs as well as other needs including energy needs. In the study area major sources of income are Agriculture, Job, Business, service in abroad countries. They make expenditure to fulfill their verities of needs. The annual income that can support annual expenditure of sample HHs is shown in below table 4.3

Table No 4.3

Distribution of the Respondent by Annual Income that can support Annual Expenditure for:

S.N	No. of Months	No. of HHs	Percentage (%)
1	1-3 months	0	0
2	4-7 months	10	20%
3	8-12 months	20	40%
4	12+ months	20	40%
Total		50	100%

Source: Field Survey, 2014

The above table shows that about (40%) households can support annual expenditure for 8-12 months. This category includes HHs mostly whose major occupation is agriculture and service.(40%) HHs said that they can support expenditure for more than 12 months; they are those HHs who are doing job involved in business, Agriculture and mostly those whose family member are in abroad for labor.

(20%) HHs can support expenditures only for 4-7 months, they all are dependent in substantive farming and have no other sources of income. Some are found installed SHS by taking loan as well as imitating for their social prestige too.

4.2.6 Increased Study Hour after Installation of SHS

In rural areas of Nepal where there is no electricity (grid and non grid), mostly people use Kerosene as sources of lighting. Students are forced to study under dim light of

tuki fueled by kerosene or torch lights that uses dry cell. The efficiency of these lights is low and students finds difficulty in studying in those environments. Solar Home System provide efficient cleaner and brighter lights which helps student to study in brighter light as well as help the family by cutting expenses required in buying kerosene. Respondent of SHS users has found increased study hours of their children has been shown in below table no 4.4

Table No.4.4

Distribution of Respondents by increased in Study Hour after SHS Installation

S.N.	Increased Study Hours Daily	No. of households	Percentage (%)
1	Increased by 1 hour	14	42.43%
2	Increased by 2 hours	16	48.48%
3	Increased by 3 hours	3	9.09%
Total			100%

Sources: Field survey, 2014

33 households out of 40 SHS installed households have their school going children. About 42.43% HHs admit that after installing SHS their children studying hours have been increased by 1 hour at night daily. Around 48.48% HHs admit increment in night study by 2 hours and 9.09% HHs admit 3 hours increment in study hour at night daily after SHS was installed.

The fact is to increase or decrease in study hours not only the solar light but various variables like studying environment, household work to be done by children etc are also crucial in determining the study hour of students.

4.3 Energy Use Situation in the Study Area

4.3.1 Fire Wood Consumption by HHs in the Study Area

Among the traditional energy resources, fuel wood is the largest energy resources in Nepal providing about 77% of the total energy demand in the year 2008/09. In Maharudra V D C also Fuel wood is the primarily sources of energy used for cooking purposes.

In Maharudra VDC the average cost of one bhari firewood of about 45 KG is Rs 60. One Kg Fire Wood is equivalent to 16.75 MJ. The annual fuel wood consumption by the respondent HHs of Maharudra VDC is shown below.

Table no: 4.6
Annual Consumption of Fuel Wood by HHS

No of houses	Quantity in vari yearly	Quantity in Kg (1 vari= 45kg)	In MJ (1 kg Fuel wood =16.75 MJ)	Total annual cost (1 vari =RS 60)
1.	120	5400	90450	7200
2.	96	4320	72360	5760
3.	120	5400	90450	7200
4.	120	5400	90450	7200
5.	96	4320	72360	5760
6.	144	6480	108540	8640
7.	180	8100	135675	10800
8.	72	3240	54270	4320
9.	180	8100	135675	10800
10.	144	6480	108540	8640
11.	144	6480	108540	8640
12.	144	6480	108540	8640
13.	120	5400	90450	7200
14.	96	4320	72360	5760
15.	72	3240	54270	4320
16.	60	2700	45225	3600
17.	144	6480	108540	8640
18.	84	3780	63315	5040
19.	72	3240	54270	4320
20.	96	4320	72360	5760
21.	144	6480	108540	8640
22.	72	3240	54270	4320
23.	72	3240	54270	4320

24.	144	6480	108540	8640
25.	72	3240	54270	4320
26.	120	5400	90450	7200
27.	72	3240	54270	4320
28.	120	5400	90450	7200
29.	96	4320	72360	5760
30.	144	6480	108540	8640
31.	120	5400	90450	7200
32.	120	5400	90450	7200
33.	72	3240	54270	4320
34.	72	3240	54270	4320
35.	180	8100	135675	10800
36.	120	5400	90450	7200
37.	144	6480	108540	8640
38.	96	4320	72360	5760
39.	144	6480	108540	8640
40.	144	6480	108540	8640
Total	4572	205740	3446145	274320
41.	120	5400	90450	7200
42.	120	5400	90450	7200
43.	60	2700	45225	3600
44.	120	5400	90450	7200
45.	120	5400	90450	7200
46.	180	8100	135675	10800
47.	120	5400	90450	7200
48.	72	3240	54270	4320
49.	96	4320	72360	5760
50.	96	4320	72360	5760
Total	1104	49680	832140	66240
Grand Total	5676	210060	3518505	340560

$$\begin{aligned} \text{The per capita fire wood energy consumed by SHS user's households} &= \frac{\text{total fuel wood energy consumption of SHS installed HHs}}{\text{total population of SHS installed HHs}} \\ &= 3446145/262 \\ &= 13153.22\text{MJ} \\ &= 13.15322 \text{ GJ/ year/person} \end{aligned}$$

$$\begin{aligned} \text{The per capita fire wood consumed by SHS non users} &= \frac{\text{Total fire wood energy consumption by SHS non users}}{\text{total population of SHS none installed HHs}} \\ &= 832140/66 \\ &= 12608.18 \text{ MJ} \\ &= 12.60818 \text{ GJ/ year/person} \end{aligned}$$

There is a little bit different amount of firewood wood energy consumed by SHS users and non-users. Economically, 2,10,060kg of fire wood is used by 50HHs equivalence to NRs 3,40,560 annually.

4.3.2 Kerosene consumption

In rural areas of Nepal kerosene is the most commonly and dominant sources of energy used for lighting. The use of kerosene in Maharudra VDC is shown below.

Table No 4.6

Distribution by Annual Consumption of Kerosene

No of HHs	Quantity in lit (yearly)	MJ(1lit=35MJ)	Total annual cost(cost/lit =Rs115)
1	1	35	115
2	2	70	230
3	1	35	115
4	0.5	17.5	57.5
5	1	35	115
6	2	70	230
7	1	35	115
8	1	35	115

9	2	70	230
10	1	35	115
11	1	35	115
12	2	70	230
13	2	70	230
14	1	35	115
15	1	35	115
16	2	70	230
17	1	35	115
18	1	35	115
19	1	35	115
20	1	35	115
21	2	70	230
Total	27.5	962.5	3162.5
1	10	350	1150
2	10	350	1150
3	12	420	1380
4	15	525	1725
5	18	630	2070
6	10	350	1150
7	18	630	2070
8	12	420	1380
9	12	420	1380
10	10	350	1150
Total	127	4445	14605
G. Total	154.5	5407.5	17767.5

Sources: Field Survey, 2014

The cost of one liter kerosene is Rs 115 in Maharudra VDC. In the above table, HHs no 1 -21 represent SHS users while HHs no 1- 10 of lower part of the table represents the SHS non users.

The above table shows that out of 40SHS only 21 HHs (52.5%) uses kerosene basically for the purpose of igniting firewood while other (47.5%) SHS households do not use kerosene. SHS non users consume more amount of kerosene as compared to the SHS users.

$$\begin{aligned} \text{The per capita kerosene consumed by SHS users} &= \frac{\text{Total consumption of kerosene by SHS installed HHs}}{\text{Total population of SHS installed households}} \\ &= 962.5/262 \\ &= 3.673 \text{ MJ} \\ &= 0.00367 \text{ GJ/year/person} \end{aligned}$$

$$\begin{aligned} \text{The per capita consumption of kerosene by SHS non users} &\times \frac{\text{Total consumption of kerosene by SHS non user's}}{\text{Total population of SHS non users HHs}} \\ &= 4445/66 \\ &= 67.345 \text{ MJ} \\ &= 0.06734 \text{ GJ/year/person} \end{aligned}$$

$$\begin{aligned} \text{Annual cost paid by SHS users households who also uses kerosene} &\times \frac{\text{Total cost paid for kerosene}}{\text{Total no. of their Households}} \\ &= 3162.5/21 \\ &= \text{Rs } 150.596/\text{households/year.} \end{aligned}$$

$$\begin{aligned} \text{Annual cost paid by SHS non user for kerosene} &\times \frac{\text{Total cost paid for kerosene}}{\text{Total no. of their HHs}} \\ &= 14605/10 \\ &= \text{Rs } 1460.5/\text{households/year.} \end{aligned}$$

The figure shows that by installing SHS a household can save at least Rs 1309 annually compared to SHS non users of Maharudra VDC. It also shows that annually 154.5 liters of kerosene is used by 31 HHs of Maharudra VDC out of 40 SHS users and 10 Non SHS users, equivalence to NRs 17767.5.

4.3.3 Consumption of Solar Energy

In Maharudra VDC 40HHs are taking advantage from the solar energy. Beside its general uses, during loadshedding the use of this solar energy is common. Then consumption of solar energy in Maharudra VDC is shown in table below.

Table no. 4.7
Annual Consumption of Solar Energy

S.N	Solar Capacity (WP)	No. of HHs	Energy (KWH)	Energy(MJ)
1	9W	2	5400	19440
2	10W	8	24000	86400
3	20W	27	162000	583200
4	40W	3	36000	129600
	Total	40	227400	818640

For calculating solar energy consumption, annually 300 days is taken as most favorable days for producing solar energy. The per capita solar energy consumption is calculated as:

$$\begin{aligned} \text{The per capita solar energy consumption} &= \frac{\text{Total solar energy consumption}}{\text{Total population of SHS installed HHs}} \\ &= 818640 / 262 \\ &= 3124.58 \text{ MJ} \\ &= 3.124 \text{ GJ} \end{aligned}$$

4.3.4 Calculation of Per Capita Energy Consumption

Energy is indispensable in modern societies. We need energy for home appliances, lighting, transportation, cooking, heating/cooling, communication, and industrial processes to produce and supply commodities of our daily needs. Thus, energy is one of the most important indicators of socio-economic development, and per capita energy consumption is often viewed as a key index of the development. Developed countries have significantly higher per capita energy consumption. For Nepal, the per capita total primary energy supply (TPES) is just 14.2 GJ/year, which is far less than

world's average per capita TPES of 76.6 GJ/year. In Maharudra the major sources of energy used are Fuel wood and kerosene.

$$\begin{aligned}
 \text{Per capita energy consumption of sola home users} &= \text{Per capita energy consumption} \\
 &\text{of firewood+ kerosene + solar} \\
 &= 13.15 + 0.00673 + 3.124 \\
 &= 13.221 \text{ GJ/person/year}
 \end{aligned}$$

Per capita energy consumption of SHS non users sample HHs of Maharudra VDC is calculated by adding Per capita consumption of varieties of energy i.e. per capita energy consumed of (Fire wood +Kerosene)

$$\begin{aligned}
 &= 12.60 + 0.0067348 \\
 &= 12.6673 \text{ GJ/Person/year}
 \end{aligned}$$

The average Per capita energy consumption including both (SHS users and non users) respondents of Maharudra VDC = $\frac{\text{total consumption of varieties of energy}}{\text{total population of the sample HHs}}$

$$\begin{aligned}
 &= \frac{3518505 + 5810 + 818640}{328} \\
 &= 13240.72 \text{ GJ} \\
 &= 13.24 \text{ GJ /person/year}
 \end{aligned}$$

The annual per capita energy consumption of sample HHS of Maharudra VDC is 13.24 GJ which is slightly less than national per capita energy consumption i.e. 14.2 GJ, the reason might be people access and right over energy is obviously low in rural parts of the country especially in rural mountainous part than in Terai .

The total energy consumption of sample households of Maharudra VDC, obtained by adding consumption of Fire wood + Kerosene+ Solar energy. The share of different types of energy is shown below in table.

Table No. 4.8**Distribution by Share of Energy in Maharudra VDC**

Types	Quantity	Energy (MJ)	Cost(NRs)	Share on Energy (%)
Biomass(kg)	210060	3518505	340560	81.02
Kerosene(lit)	154.5	5407.5	17767.5	0.13
Solar PV(kwh)	227400	818640	604000	18.85
Total		4342552.5	1005527.5	100

As we know Nepal's energy sector heavily reliance on traditional sources (87%). The share of fire wood energy is maximum among total energy consumption in Maharudra VDC, which is 81.02%. Annually 2,10,060 kg, 35,18,505MJ energy is derived from biomass equivalence to Rs 3,40,560 by the sample HHs.

The share of Commercial Energy is 0.13% which is comparatively low in compare to traditional energy sources. Annually 5407.5 MJ energy is derived from Commercial sources equivalent to Rs 17768 by sample HHs of Maharudra VDC.

The share of Solar PV Energy is 18.85% .Annually 818640MJ energy is derived from Solar PV by 40 SHS installed households at the cost of approximately Rs 604000.

4.4 Solar Home System Use Information in Study Area

4.4.1 Distribution of SHS by Date of Installation

Households of Maharudra VDC have installed SHS in different years, which are shown below in table:

Table No 4.9
Date of Installation of SHS by Year

S.N	Year of Installation	No. of Households	Percentage (%)
1	2064	1	2.5
2	2066	3	7.5
3	2067	9	22.5
4	2068	7	17.5
5	2069	5	12.5
6	2070	14	35
7	2071	1	2.5
Total		40	100%

Sources: Field Survey, 2014

In Maharudra VDC highest no. of solar home system (35%) was installed in year 2070. Then there was no record of any installation from 2061 to 2063. In the year 2064 BS there is lowest no. of households installing SHS to 2.5% and in the year 2068 and 2069 then again there is gradual decreased of Households installing SHS is 17.5% and 12.5% respectively.

4.4.2 Distribution of SHS by system Size and cost

Different households use SHS of varying capacity from 9WP up to 40WP considering their energy needs, cost of the system etc. The various sizes and cost of the systems installed in Maharudra VDC are shown below in table no 4.10

Table No. 4.10
Distribution of SHS by system Size and Cost

S.N	Size of the System (WP)	No. of HHs	Percentage	Range of Average Cost Per System(RS)
1	9	2	5	4,500-7,500
2	10	8	20	7,500-9,000
3	20	27	67.5	10,000-17000
4	40	3	7.5	25,000-40,000
	Total	40	100%	600000-800000

Sources: Field Survey, 2014

The above table shows that highest no of households (67.5%) has installed 20wp system .The reason for its maximum use might be because of its average cost and it also fulfills the basic energy requirements of the households. About 20% households have use 10wp solar home system. Percentage of households using 40wp is (7.5%) which is low in no, it might because of its high cost and they are generally not only for household lighting purposes but also for commercial purposes.

There is no uniformity regarding the cost of Solar Home System. The cost of same size system also varies as per the installing company. The range of average cost for 9wp is between Rs 4500 to 7500.The cost of 10wp varies between 7500-9000 and cost of 40wp lies between Rs25,000 to 40,000. In total the average cost of these 40

SHS is between NRs 6 to 8 lakhs. There should be effective efforts to make uniformity in cost so that users can get optimum benefits from it.

4.4.3 SHS Installer Company in the Study Area

There is no. of authoritative companies that assemble different components of the solar home system and helps local people in install solar home system. In the study area, 5 different solar companies have launched their programs from 2064 to 2071Bs are shown in table no 4.11

Table No.4.11
Distribution by SHS Installer Company

S.N	Name of the Company	No. of Households	Percentage (%)
1	Dhaulagiri Solar Energy Pvt. Ltd	14	35
2	Everest solar Company	15	37.5
3	Khapad solar company	4	10
4	PRC	5	12.5
5	Kathmandu solar company	2	5
	Total	40	100%

Sources: Field Survey, 2014

Among the companies, the most popular company is Everest Solar Company Pvt Ltd which has alone installed 37.5% of the total SHS installed in Maharudra VDC. The second popular Company is Dhaulagiri Solar Energy Pvt. Ltd which has installed about 35% SHS in Maharudra VDC and Kathmandu Company is the least popular with only 5% installation.

The goodwill of the company, its service and facilities, promotions, prices of the system, personal and other relations etc play role in deciding the popularity of the company.

4.4.4 Information Means/Sources in the Study Area

Energy plays vital role in making access to information and technology. Different electronic means like Television, radio, mobile phone etc are used as source of information in the study area is shown below in table:

Table No 4.12
Information Sources in the Study Area

S.N	Type of Sources	No. of Households	Percentage (%)
1	Phone	37	92.5
2	Radio	35	87.5
3	Television + Radio + Phone	1	2.5

Sources: Field Survey, 2014

Out of 40 SHS installed households, 87.5% households have at least a radio in their homes. Similarly 92.5% household has at least a mobile phone with anyone of their family member. Only 2.5% of SHS installed household has Radio, Television and Phone.

4.4.5 No. of Bulbs Used by Households in the Study Area

No. of bulbs used for lighting by households in the study area varies as per system capacity, types of bulbs used, no. of family size etc, which is shown in the table below in table no 4.13

Table No 4.13
Distribution of Bulbs for Lighting

S.N	No. of Bulbs	No. of Households	Percentage (%)
1	1-4	24	60
2	5-7	16	40
	Total	40	100%

Sources: Field Survey, 2014

The above table shows that more than half of the Solar Home System installed households (60%) in Maharudra VDC has 1 to 4 bulbs used for lighting 40% households has bulbs between 5 to 7 and no households has bulbs more than seven.

The no of bulbs depends upon the system capacity, requirements of the house and on types of bulbs used for lighting. During the study it is found that all bulbs are not used

at a time by households, they are used alternately. Appropriate no. of bulbs as per system capacity helps in longevity of battery and panel.

4.4.6 Types of the Bulbs Used in the Study Area

The efficiency of the solar energy greatly depends upon the types of bulbs used rather than in no. of bulbs. The light produced by bulbs like CFL, W/LED is cleaner, brighter and efficient than tube light. In the study area different types of bulbs are found using by households is shown below in table no.4.14

Table No 4.14
Distribution of Bulbs According to Types and Watts

S.N	Types of Bulbs	Watts	No. of Households	Percentage
1	Only CFL	5, 10	5	12.5
2	Only Tube	5,10	1	2.5
3	CFL+Tube	5,10	19	47.5
4	Tube+LED	5,10 and 1.5,2.5	4	10
5	CFL +LED	5,10 and 1.5,2.5	8	20
6	CFL+Tube+LED	5,10 and 1.5,2.5	3	7.5
	Total			100

Sources: Field Survey, 2014

Among the bulbs most households (47.5%) are using CFL and Tube while 20% households are found using CFL and W/LED bulbs ,12.5% households are using only CFL ,10% households are found using Tube and LED, and 7.5% households are using all CFL.LED and Tube and remaining only 2.5% are using only Tube.

In the field the SHS users are found quite aware about advantages of high efficient bulbs and the trend of using them are in fashion.

4.4.7 SHS used for Lighting

The main purpose of installing SHS in rural areas like in Maharudra VDC is primarily for lighting in nights. Solar energy is mostly use to do households work in night, for children to read and write as well as for other commercial purposes like lighting for

hotel, shop, poultry etc. No. of hours used for lighting on the basis of households is shown below in table no 4.15

Table no 4.15
Solar Home System Used Daily for Lighting in Night

S.N	No. of Hours Used for Lighting	No. of Households	Percentage (%)
1	For One Hour	--	--
2	For Two Hours	25	62.5
3	For Three Hours	15	37.5
	Total	40	100%

Sources: Field Survey, 2014

The above table shows that 62.5% of total SHS installed households agreed that they use SHS for about 2 hours for lighting daily in night. 37.5% households use SHS for lighting 3 hours daily while none of the households use SHS only for 1 hour daily. In Maharudra VDC most of the respondents are farmer, so the general use of solar light is for kitchen works at night and for student to study one/two hours at night.

4.4.8 Environmental Impact of SHS Compared to Kerosene Lamp

Regarding the environmental impact of SHS compared to kerosene lamp there is common general answer that almost 100% respondents of Maharudra VDC state that kerosene lamp produce smoke that makes room dirty as well as there was chances of accident of fire hazards but solar energy is smokeless and it helps their children to study more and helps to keep the room clean and bright.

4.4.9 Major Problems Faced with SHS

Using solar energy technology requires proper knowledge and understanding from its beginning installing phase to its use, operation and maintenance. The initial cost of SHS is quite high in compare to traditional sources of energy so many people find it unaffordable. Beside this, proper guidelines are required for its operation and

maintenance. Some major problems faced by SHS users of Maharudra VDC is shown below in table no 4.16

Table No. 4.16
Major Problems Faced by SHS Users

S.N	Types of Problems	No. of Households	Percentage (%)
1	Cost	7	17.5
2	Operation/Maintenance	15	37.5
3	Both cost and Maintenance	10	25
4	Less efficient during bad weather	8	20
	Total	40	100%

Sources: Field Survey, 2014

The above table shows that 17.5% households take SHS cost is high for them while 37.5% households faced problem of operation and maintenance like battery fuse, changing water level in battery etc. 20% HHs complains that during rainy season when weather is cloudy the energy produced by their SHS is not enough for them, so the cost of SHS should be reduced by giving more incentives to rural low income households as well as there should be awareness programs on SHS and skilled technician available in village for its maintenance.

CHAPTER FIVE

ENERGY SCENARIO, SOCIO- ECONOMIC AND OTHER IMPACTS OF SHS

Nepal's energy resources are presently classified into three categories namely the traditional, commercial and alternative. Traditional energy resources include fuel wood from forests and tree resources, agricultural residues coming from agricultural crops and animal dung in the dry form. Energy resources coming under the commercial or business practices are grouped into commercial energy resources that particularly include the coal, grid electricity and petroleum products. Biogas, solar power, and micro level hydropower are categorized into the alternative energy resources in Nepal. In Maharudra VDC there was no hydroelectricity but only kerosene, fuelwood and solar energy are in use.

5.1 Energy Scenario

5.1.1 Scenario of Fire Wood Consumption

Among the traditional resources fire wood consumption is very high. i.e 81.02 % of total energy consumption in sample HHs of Maharudra VDC. About 210060 kg, 3518505 MJ equivalent to Rs 340560 is derived from firewood. Both SHS users and non users use almost similar quantity of firewood mainly for cooking purpose which varies from 10 to 12 Bhari per month.

The excessive use of fire wood energy is not a new phenomenon, almost in all rural parts of Nepal, fire wood is the most common and major sources of energy. The Maharudra VDC is surrounded by community forestry so people access to fire wood is easy, cheaper, and using it for cooking purpose is like the part of their way of living which all leads to the maximum use of fire wood than any other resources in the study area.

5.1.2 Scenario of Consumption of Kerosene

Among the commercial energy sources, the mostly used common source of energy in Maharudra VDC is kerosene. The consumption of kerosene is very low in SHS installed households about 1 to 3 liters per year which they mainly use for igniting firewood, in those parts of house where light bulbs are not installed. In some SHS installed households the consumption of kerosene is totally replaced by solar energy.

The solar home system non users consume annually about 10 to 15 liters of kerosene basically for the purpose of lighting. A SHS installed households save at least NRS 1309 annually by the application of SHS than SHS non users. In total about 154.5 liters, 5407.5 MJ energy equivalent to RS 17768 is consumed by sample HHs of Maharudra VDC.

5.1.3 Scenario of Solar Energy Consumption

Under the AEPC about most of the HHS of Maharudra VDC had installed the SHS in subsidy. They are found using 9WP system to up to 40WP system using CFL, Tube light, W/Led bulbs of 2.5, 5 and 10 watts for lighting respectively. Annually 818640 MJ energy is derived from 40 SHS installed HHs in Maharudra VDC.

There is no grid electricity people still depends highly on solar energy. There should be provision on easily availability of SHS components, skilled technicians and awareness program on SHS which will help in further development and promotion of SHS.

5.1.1 Per Capita Energy Consumption

The average per capita energy consumption of sample HHs of Maharudra VDC is 13.62 GJ/person/year. The per capita energy consumption is calculated by adding different forms of energy used by population of the sample households. Consumption of Firewood, Kerosene and of Solar PV all was converted into one measurable unit in MJ and their addition was divided by total population of the sample households.

The average per capita energy of sample HHS of Maharudra VDC almost tally with national per capita energy consumption i.e. 14.2 GJ. Still Per Capita Energy

Consumption is less, the reason might be people access and right over energy is obviously low in rural parts of the country especially in rural mountainous part than in Terai, and similarly the consumption of energy is also very low in rural part of the country compared to urban areas.

5.3 Socio- Economic and Other Impacts

As we have already mentioned that in remote areas where electric energy as well as other sources are less viable and costly, the SHS will be an effective substitute which increases people access to energy and helps to adopt a better way of living. Installing SHS has several benefits which are discussed below;

5.3.1 Social Benefits

Among the various social benefits noticed by SHS users of Maharudra VDC, the major benefits we are going to discuss here is its positive impact on Education and Women Empowerment.

Students were compelled to study under dim light of tuki before the installation of SHS. The light coming from that kerosene powered tuki was not bright enough, smoky and causes headaches for children to study. After SHS installation, under the clean and bright, non smoky light children are found increased their study hour from at least 1 hour per night to up to 3 hours.

SHS powered communication sources like TV, Phone etc has played great role in increasing awareness about gender equality in the villagers. People are made aware to send their girls also to schools. Other social benefits like women can save time and energy required in searching fuel wood etc have been decreased. Beside this women perform different households and income generating activities in solar lights at night like “storing grains, batti kathne, tapari bunne, stetching clothes etc which has helped in overall development of women of Maharudra VDC.

5.3.2 Economic Benefits

Among the various economic benefit, one of the important economic benefit is it saves the money for kerosene, torch light batteries etc which helps to boost the

economic condition not only of the households but of the entire country. The money paid for import of these oil products will be reduced by SHS and helps to reduce the trade deficit.

Solar energy has provided gateway to run different income generating activities at Maharudra VDC. Beside this it has helped in diversification and commercialization in rural areas. By using solar energy different income generating activities like making handicrafts, woolen products, poultry farming etc had been run. These solar lights are also used in local shops, hotels at night which also help to increase the business. In conclusion this solar energy is helping in developing and promoting entrepreneurship at local level.

5.3.3 Environmental Benefit

One of the most important benefits of solar energy is it cuts the carbon footprint. Solar electricity is green, renewable energy and doesn't release any harmful carbon dioxide (CO₂) or other pollutants. A typical home solar PV system could save over a tone of CO₂ equivalent per year - that's more than 30 tones over its lifetime. (Wikipedia)

The benefit is solar light do not produce indoor air pollution like kerosene lamps and it also reduces the chances of accidental fire hazards. Respondents also noticed that due to availability of solar energy and other various forms of energy community forest has been conserved well.

5.3.4 Health Benefits

According to the respondents, Health benefits like respiratory diseases, headache, and fire hazard etc due to smoke of fire wood won't be there in solar lights. In health post of VDC solar energy is used to run refrigerator to keep the vaccines, as well as provides light to run health facilities at night during emergency.

5.3.5 Poverty Reduction and Rural Development

According to Nepal Living standards survey (NLSS-III, 2010-11) poverty rate is 25.16 percent. The poverty is much higher in rural areas (27.43%) than in urban areas

(15.46%). Generally poor people highly depend upon traditional sources of energy. The energy price influences the energy use (consumer choices and behavior). Higher the per capita energy consumption signifies higher human development index (HDI). Similarly rural development is the strategy of fulfilling the basic necessities of people with high degree of self respect and freedom. People access to solar energy and its various positive impacts plays crucial role in poverty reduction and rural development as follows

Firstly solar energy helps in increasing people access to energy. In remote parts where SHS is highly feasible and less costly than development of any other form of energy, SHS will be a wise substitute. Higher the per capita energy consumption signifies higher human development index (HDI).

Secondly, solar energy in one hand help to reduce the consumption of imported fossil fuels and on the other hand helps in initiating income generating activities at local level. So it saves huge money from paying to kerosene as well as for other fuels. Different income generating activities like making handicrafts, tailoring, weaving woolen products, poultry farming etc can be run from solar energy which helps in overcoming economic vulnerability in rural remote areas.

Thirdly SHS plays role in development of social sector like education, health, women empowerment etc. Students can read and write well in cleaner and brighter solar light, solar energy can be used in running computer at school, to run health facilities in night and keep medicine cool in refrigerator in local area. Other social benefits like women can save time and energy required in searching fuel wood etc will be decrease. Women perform different households and income generating activities in solar lights at night like “batti kathne, tapari bunne, making woolen bags etc which has helped in overall development and empowerment of women.

Fourthly, it also has increased the people access to information through TV, Phone, Radio so that people have got opportunities to learn and understand different socio-economic, political aspects of the entire world. Their way of living has been transformed to modern, competitive and creative living.

In conclusion access to Solar energy has helped rural people to boost their income, to study more and towards overall development of their lives and make them self reliant which certainly plays crucial role in reducing the poverty and in rural development.

5.4 Problems Faced with SHS

There is no doubt that SHS has helped local people not only by providing energy but also from its positive consequences on social, economic, environmental and on other various aspects of lives. In spite of its high degree of usefulness, some problems faced with SHS in Maharudra VDC are as follows;

- 1) **Cost:** Though there is subsidy, the initial installing cost of SHS is high. It is really difficult for low income people to install SHS. About 17.5% respondents of Maharudra VDC find the Cost of SHS as a major problem during its installation and for further promotion and development.
- 2) **Maintenance:** Maintenance problem like fuse problems, changing distilled water in battery, low durability of battery and charge controller etc are the problems frequently faced by SHS users of Maharudra VDC. More than 37.5% HHs of the study area finds maintenance as major problems. Lack of skilled manpower and repairing centers is also another problem for them.
- 3) **Less operating hours during Bad Weathers:** About 20% HHs of the study area finds less working hours of SHS during cloudy, rainy and humid day. The lights were not brighter enough and even all loads don't work during such time.

CHAPTER SIX

MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Major Findings

Following are some of the highlights of the key findings:

-) Maharudra VDC of Baitadi district is the study area.
-) The VDC has 712 households with total population 4080, male 1871 and female 2209.
-) It is found that out of total households, 40 households have been taking advantage from solar energy 10 HHs do not have solar home system due to poverty.
-) All these 40 HHs who are the users of SHS taken as sample HHs (100%) and 10 SHS non users HHs is also taken as sample households. ie, total sample HHs is 50.
-) The total population of sample households is 328 persons, male 155 (47.25%) and female 173 (52.75%).
-) In the study area average HHs size is found to be 6.56.
-) The total area of Maharudra VDC is 16.29 sq km.
-) Highest no of households in the study area are Brahmin(48%) followed by Dalit(26%) , Chhetri(22%) and Pujara (4%).
-) The average literacy rate of sample HHs is (70.12%), Male literacy (71.51%) and female literacy rate (64.16%).
-) Major occupation status of the sample HHs, Agriculture 58%, service 14%, job 12%, service in abroad countries 10% and business 6%.
-) 40% sample households agreed that their income supports expenditure for 8-12 months while 40% sample HHs for 12+ months and 20% for 4- 7 months.
-) After the installation of SHS, 42.43% sample HHs noticed the increased of study hours of their children by 1 hour, 48.48% HHs by 2 hours and about 9.09% households by 3 hours per day.

-) Fire wood is the most common and highly used sources of energy by both SHS users and non users. It shares the highest value in per capita energy consumption calculation. About 3518505 MJ, energy is used by 50 samples HHs annually in the study area equivalence to NRs 340560.(At the rate 1Bhari=Rs 60 and 1Bhari=45 Kg)
-) Only 52.5 % SHS installed households use kerosene for igniting fire and for maintenance period, while 100 % solar home system non-users use kerosene.
-) The per capita energy consumption from kerosene is 0.00673 GJ (27 l) which is very low than solar home system none users i.e 0.067348 GJ (127.5 l).
-) By installing solar home system, the HHs can save at least NRs 1309 annually to up to 100% money used for paying kerosene.
-) Annually 154.5 liters of kerosene is used by sample HHs (including both SHs users and non users) equivalence to NRs 17767.5.
-) The per capita energy consumption of solar energy is 3.124 GJ.
-) The Per capita energy consumption of SHS users is 13.21 GJ which is higher than SHS non users i.e. 12.66 GJ.
-) The average Per capita energy consumption of total 50 samples HHs of Maharudra VDC is 13.62 GJ which is slightly less than national per capita energy consumption.
-) In the study area, SHS installation has started from 2064 BS with least no of installation 2.5% (1Hhs) only, highest no. of installation 35%(14Hhs) in the year 2070 and last recorded installation was in the year 2071 BS by 2.5%(1Hhs) till Baisakh.
-) 20Wp SHS is most popular in the study area used by 67.5%(27) HHS, 10Wp was used by 20%(8) HHs,40Wp was used by 7.5%(3) and lowest household about 5%(2Hhs) has installed 9Wp system.
-) The prices of same capacity SHS also varied according to installing company. The average cost of installation of 9Wp system lies between 4,500 to7, 500. The average cost of 10 Wp system lies between 7,500 to 9,000 and the average cost of 40Wp lies between 25,000 to 40,000 in the study area.

-) Among 5 solar energy companies in Maharudra VDC, most popular company is Everest Solar company, which has alone installed 37.5%(15) followed by Dhaulagiri Solar Energy Pvt. Ltd 35%(14) of the total SHS installed .
-) In the study area 92.5% (37) HHs takes mobile phone as major source of information while 87.5%(35) household has radio as source of information and only 2.5%(1) HHs uses all TV, radio and phone.
-) 60% (24) sample households in the study area had installed 1 - 4 no. of bulbs, 40% (16) HHs has 5-7 Bulbs.
-) In the study area 47.5%(19) HHs uses CFL and Tube Light, 20% (8)HHs uses CFL and W/LED, 12.5%(5) HHs uses only CFL,20%(8) uses CFL and LED,10%(4) Tube and LED,2.5%(1) uses only Tube and 7.5%(3) HHs use all three CFL, Tube light and W/LED. The less no. of LED bulbs is due to unavailability and high cost in the local market.
-) 62.5% (25) HHs uses SHS for lighting for about 2 hours per day while 37.5% (15) HHs used for 3 hours and none of the HHs used only for 1 hour per day.
-) 100% sample HHs agreed that SHS helped them to keep home environment clean and healthy compared to kerosene.
-) About 37.5% (15) SHS users faced problems with its maintenance while 17.5% HHs find it costly,25%(10) had replied the problem of both cost and maintenance and 20 %(8) HHs complain about its less operating hours during bad weathers.

6.2 Conclusion

Energy is taken as one of the most important indicators of socio-economic development. It is one of the vital inputs to livelihood and consistent availability of affordable energy sources are the prerequisites of socio-economic development of the country. It is believed that higher the per capita energy consumption, higher will be the Human Development Index (H.D.I). So efforts should be made to increase people's access and application of various forms of renewable energy throughout the nation, so that per capita energy consumption increases significantly.

Despite Nepal's huge potential for hydro electricity, it has not been able to harness its full potential due to various reasons. Currently, less than 15% rural population is connected to the national grid while the rest of the population still relies on traditional sources of power. Even in electrified areas, there has been acute power shortage in recent years, with residents forced to live in as much as 16 hours of daily power cuts. In light of this situation, solar energy has been identified as one of the alternative sources of electrical energy.

Nepal being located in favorable latitude, receive ample solar radiation. On average Nepal has 6.8 sunshine hours per day with the average intensity of solar insolation of about 4.7KWh/m²/day. Using photovoltaic (PV) modules of 12% efficiency and assuming peak sunshine of 4.5 hours per day, the total energy generated would be 80,000 GWh/day. Thus the development of solar energy is a wiser option for fulfilling the country's energy demand.

Solar electricity has numerous end use applications such as lighting, on health, education and communication etc. By the promotion of the solar energy 40HHs of Maharudra VDC had been benefited from the cleaner, brighter and smokeless light that has increased the study hour of the children at night. The users are also free from health problems like headaches, respiratory problem, eye infection etc caused by smokes from fire wood and kerosene.

People access to information has also increased and no. of households with TV, Radio, Phone has been increased which eventually has increased the public awareness on various social, economic, political etc issues and on the way of living. The people's awareness increases and their blind support to the political parties has also decreased which strengthen the democratisation. People has started sending girls to school, women entrepreneurship at local level has been started.

SHS in one hand has reduced the households expenditures used for purchasing the fossil fuel, on the other hand it has increased the probability of initiating own business and income generating activities in local level like poultry farming, communication services, tailoring , hotel business etc supporting local people to earn and utilize their extra time.

As solar electricity is green, renewable energy it doesn't release any harmful carbon dioxide (CO₂) or other pollutants to the environment .So it is eco-friendly and most appropriate technology for the electrification of rural remote areas.

All the respondents of Maharudra VDC have very positive attitudes towards SHS and they agreed that it had helped them in development of socio economic and other various aspects of their lives. Still reduction in the cost of installation and provision of skilled technicians for operation and maintenance of SHS at local level is most for its further promotion and development.

6.3 Recommendations

As already mentioned above that SHS is a wiser and most appropriate solution for lighting not only remote areas but also urban areas where shortage of electricity is common problem. Based on the study following recommendations are made for its wider applications throughout the nation.

A) Regarding the Cost

- 1) The initial cost of installing SHS is high such that all people can't support it. So subsidy should be increased for the rural areas while there should be additional provision of subsidy to urban areas people who are willing to install it.
- 2) Beside subsidy government should provide incentives in imports and transportation of components of solar energy system rather than providing incentives to kerosene oil.
- 3) The cost of installation of same capacity in the same locality also differed as per the installing company. So cost of installation according to its capacity and geographical region should be fixed by concerned government authorities.
- 4) There should be the provision of minimum interest loan and insurance policy for SHS.
- 5) SHS installation should be made as much possible as free for those poorest people of remote areas where grid electricity infrastructure seems costly.

B) Regarding Maintenance

- 1) Government should run campaign to make people aware about SHS, its use and impact on the users.
- 2) Repairing centers and shops for buying and repairing different components of SHS should be made available within the locality.
- 3) People's easy access to skilled technicians on SHS should be made available at local level.

C) Policy Level

- 1) Primarily research is foundation for making any kind of policy, so research centers on solar energy with involvement of experts should be run in different part of the nation.
- 2) There should be long term (about 20 years) perspective plan on solar energy with clear objectives and fixed targets on installing SHS throughout the nation.
- 3) Government should make policy on commercial production of solar energy and provision of selling it to the grid connection.
- 4) Effective implementation of clean development mechanism (C.D.M) for solar energy should be ensured.
- 5) Effective monitoring and evaluation of various institutions and programs on solar energy should be done by the third party or government agencies on regular basis.

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A Study on Socio–Economic Impact of Solar Home System on Community

A case study of Maharudra VDC, Baitadi District, Nepal

Questionnaire

(A) Demographic/ Educational

1. (i) Household owner Mr/Ms/Mrs.....
- (ii) Household sizeAge.....Sex.....
- (iii) Occupation

2. Family members

Sex/Age	Below 15	Above 15
Male		
Female		
Total		

3. What is the educational status of the family?

Sex/level	1–5	6–10	SLC	+2 Level	Graduates	Illiterate
Male						
Female						
Total						

B. Socio–Economic

4. What is the occupation of the family members?

Sex/occupations	Student	Farmer	Teacher	Business	Civil service	other
Male						
Female						
Total						

5. How much your annual income is?

Income Rs.	Expenditure Rs.

6. How much months your family's income can support the household expenditure for?
- a) 1–3 Months b) 4–6 Months
 c) 7–10 Months d) 10–12 Months e) More than 12

7) How much energy is consumed in your house?

Type	Quantity	Annual consumption D/W/M/A	Energy (MJ)
Fuel wood			
SKO/kerosene			
Dungcake			
Agricultural residue			
Others			

D. Solar Home System

8) Do you have solar home system?

- a) Yes b) No

If no, why?

1).....

2).....

9) When did you installed solar home system?

.....B.S

10) Which company has provided the SHS?

Name of company.....

11) What is the cost of your SHS?

Rs.....

12) Did you get any subsidy from the gov/Non gov. organization?

- i) Gov ii) Non gov.

13) Did you take loan for this purpose

- a) Yes b) No

Bank amount

Relatives

- 14) What type of electrical appliances do you use in your home?
 a) TV b) Radio c) Phone d) Others

15). No. and types of bulb used

Types of lamps	No	Watts	Origin
CFL only			
Tube only			
CFL+Tube			
CFL+LED			
Tube+LED			
CFL+Tube+LED			
Others			

16). How many hours do you use the appliances in your home? daily?

- a) Lighting
 b) TV
 c) Others

17). What is the difference in the consumption of kerosene and firewood after the installation of SHS?

Items	Before	After	Difference
Fuel wood (Bhari)			
Kerosene (Litre)			

18). How many hours SHS provide energy for lightening in your home?

19). Has it brought any difference in your daily life for working hours?

20). Has it improved the household environment and sanitation?

- a) Yes..... b) No.....

If yes how?

- i)
 ii)

21). What are the problems you have been facing from solar home system?

22). Are you satisfied with the SHS?

a) Yes b) No

23). Has the expenditure on your health reduced after solar home system installation?

a) Yes b) No

24). Do you feel that solar home system has increased your life standard and prestige

a) Yes b) No

25). Did you get any trainings on SHS?

a) Yes b) No

If yes which organization?

.....

26)). How is the impact of SHS on health status of solar home system users?

Particulars	Positive		Negative		No difference	
	Male	Female	Male	Female	Male	Female
Eye irritating (Pain)						
Headache						
Chest pain						
Coughing						
Respiration						

27). Do you have any suggestions about solar home system installation?

Thank you! for providing your valuable time and information .

Respondent Households of the Survey

S.No	Household Owner Name	Address(VDC)	Village	Ward No.
1	Dipak Joshi	Maharudra	Kandae	1
2	Rabindra Chand	Maharudra	Khaligad	1
3	Radhika Joshi	Maharudra	Kandae	01
4	Laxmi Chand	Maharudra	Khaligad	01
5	Harish Joshi	Maharudra	Kandae	01
6	Bharat Dayal	Maharudra	Lohargau	02
7	Jay Bahadur Chand	Maharudra	Khaligad	01
8	Padam Raj Joshi	Maharudra	Kandae	01
9	Hari Datt Joshi	Maharudra	Kandae	01
10	Narayan Datt Joshi	Maharudra	Kandae	01
11	Tara Datt Joshi	Maharudra	Kandae	01
12	Jay Datt Joshi	Maharudra	Kandae	01
13	Fanendra Datt Pant	Maharudra	Panteuda	01
14	Hari Datt Joshi	Maharudra	Kandae	01
15	Damodar Joshi	Maharudra	Kandae	01
16	Bashudev Pant	Maharudra	Panteuda	01
17	Bir Datt Pant	Maharudra	Panteuda	01
18	Narayan Datt Pant	Maharudra	Panteuda	01
19	Sita Devi Pant	Maharudra	Panteuda	01
20	Ran Bahadur Chand	Maharudra	Khaligad	01
21	Krishna Bahadur Chand	Maharudra	Khaligad	01
22	Ran Bahadur Chand (2nd)	Maharudra	Khaligad	01
23	Gagendra Chand	Maharudra	Khaligad	01
24	Dabal Bahadur Chand	Maharudra	Khaligad	01
25	Ram Singh Khatri	Maharudra	Khaligad	01
26	Krishna Singh Khatri	Maharudra	Khaligad	01
27	Ramesh Joshi	Maharudra	Bhumka	01
28	Mani Datt Pant	Maharudra	Panteuda	01
29	Krishna Damai	Maharudra	Lohargau	02

30	Rami Dayal	Maharudra	Lohargau	02
31	Birendra Pokharel	Maharudra	Lohargau	02
32	Chandra Dev Pant	Maharudra	Panteuda	01
33	Surendra Chand	Maharudra	Khaligad	01
34	Dharm Damai	Maharudra	Lohargau	02
35	Karan Damai	Maharudra	Lohargau	02
36	Govinda Ballab Joshi	Maharudra	Kandae	01
37	Balbhadra Joshi	Maharudra	Kandae	01
38	Gopi Dayal	Maharudra	Lohargau	02
39	Dashrath Dayal	Maharudra	Lohargau	02
40	Arjun Dayal	Maharudra	Lohargau	02
41	Gopi Datt Pant	Maharudra	Panteuda	01
42	Sai Ram Damai	Maharudra	Lohargau	02
43	Kamal Dayal	Maharudra	Lohargau	02
44	Sunita Dayal	Maharudra	Lohargau	02
45	Dhani Dayal	Maharudra	Lohargau	02
46	Krishna Joshi	Maharudra	Kandae	01
47	Ram Singh Pujara	Maharudra	Pelya	03
48	Ganesh Singh Pujara	Maharudra	Pelya	03
49	Khem Raj Bhatt	Maharudra	Bhumka	01
50	Hari Datt Bhatt	Maharudra	Bhumka	01