THE ROLE OF SOLAR ENERGY ON COMMUNITY DEVELOPMENT

(A CASE STUDY OF CHANDRAGIRI MUNICIPALITY 13 AND 14, MACHCHHEGAUN, KATHMANDU)

A THESIS SUBMITTED TO THE
BHAKTAPUR MULTIPLE CAMPUS
FACULTY OF HUMANITIES AND SOCIAL SCIENCE
DEPARTMENT OF RURAL DEVELOPMENT
TRIBHUVAN UNIVERSITY
NEPAL

IN PARTIAL FULFILLMENT
OF REQUIREMENTS FOR THE MASTER'S DEGREE
OF ARTS IN RURAL DEVELOPMENT

BY
KRISHNA KUMAR SHRESTHA
TU REGISTRATION NO: 3-1-26-178-2004
EXAM SYMBOL NO: 200020
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RECOMMENDATION

The thesis entitled **"The Role of Solar Energy on Community Development (A Case Study of Chandragiri Municipality 13 and 14, Machchhegaun, Kathmandu)"** has been prepared by **Krishna Kumar Shrestha** under my guidance and supervision. I hereby forward this thesis to the evaluation committee for final evaluation and approval.

.....

Prajapati Khanal
Thesis Supervisor
Date: December, 2016

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APPROVAL LETTER

On the recommendation of **Mr. Prajapati Khanal**, this thesis entitled **"The Role of Solar Energy on Community Development (A Case Study of Chandragiri Municipality-13 and 14, Machchhegaun, Kathmandu)"** submitted to the Department of Rural Development under the faculty of Humanities and Social Sciences, Bhaktapur Multiple Campus, Tribhuvan University by **Krishna Kumar Shrestha** has been approved by the members of the Thesis Evaluation Committee.

Thesis Evaluation Committee

Prajapati Khanal
Supervisor

Bin Bahadur Tamang
External Examiner

Prajapati Khanal
Head of Department

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First of all, I would like to acknowledge The Department of Rural Development, Bhaktapur Multiple Campus for providing an opportunity to carry out this project work on 'The Role of Solar Energy on Community Development (A Case Study of Chandragiri Municipality-13 and 14, Machchhegaun, Kathmandu)'. I would like to express my sincere gratitude to my supervisor Mr. Prajapati Khanal, Head of Department of Rural Development, Bhaktapur Multiple Campus for his kind guideline, suggestion and consistent inspiration to conduct and complete of this study. My gratitude goes to all the staff of the department for their support during the study.

I would like to express my appreciation to all the respondent of Chandragiri Municipality-13 and 14, Machchhegaun, Kathmandu district. Similarly, I would like to express my sincere gratitude to Mr. Hira Krishna Maharjan, Secretary of Ward office, Chandragiri Municipality-13/14 and local resident providing me a big hand on my field work for this thesis.

Special thanks go to Mrs. Shanti Maharjan, Mr. Sanjaya Manandhar, Mr. Dev Kumar Deshar and Mr. Purshotam Shrestha for their help in collection of data.

Last but not the least, my deep love and respect goes to my parents, family members and friends who always inspire and helped me a lot to build my educational career.

It is hoped that this report tried to portray accurately the energy scenario, the potential impact of using trend of solar energy on rural development and promotion of sustainable renewable energy in the future.

Krishna Kumar Shrestha

ABSTRACT

The thesis entitled "The Role of Solar Energy on Community Development (A Case Study of Chandragiri Municipality-13 and 14, Machchhegaun, Kathmandu)" was conducted with the objectives finding the relation between using trend of solar energy and community development. This study is mainly based in the primary information and the data were collected using the techniques of field survey with the help of questionnaire, field visit and observation.

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 community development and plays vital role in increasing and improving the living standard.

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. Solar technological advancement and community development are truly related to each other. The development of the community depends upon the types of energy being used and level of the technology for the consumption of that energy.

In Machchhegaun, people generally use Liquid Petroleum Gas (LPG), Electricity, and Firewood as sources of cooking fuel. There is grid electricity connection in all houses, although due to load shedding for several months from past decades. Candles and Tukis (Fuel Lamps) were used for lighting before the rechargeable lights were introduced but after solar technology most of the households use it as alternative source of light than rechargeable lights.

The study is based on exploratory and descriptive research design. In the field survey out of 872 households, 40 households data were collected from purposively selected, 38 users of solar electricity and 2 non user's household using semi structured interview schedule. Also the required data were collected from public places where solar technology being used. There are different types of people from different caste and ethnic background with different economic and educational status. So the site represent the typical Nepalese community. Largest population in the Machchhegaun is Newars.

Solar electricity of 20w to 100w is most popular in the study area. Solar technology has been mainly used for lighting and heating water in the study area. Solar technology has been found well-functioning in the study area, with good lighting facility.

There is grid electricity connection in all houses, although due to daily load shedding for several months. Most of the households have been taking significant advantage from solar technology. Recently many people starts using solar geyser for heating water. Solar technology saved monthly fuel expenditure to maximum extent. Solar electric system has been helpful for reducing work load and increasing leisure time. It is found that the solar technology is going on developing as community development.

ABBREVIATIONS / ACRONYMS

AC	Alternate Current
AEPC	Alternative Energy Promotion Center
CADEC	Community Awareness Development Centre
CBS	Central Bureau of Statistics
CDM	Clean Development Mechanism
DC	Direct Current
ESAP	Energy Sector Assistance Program
GHG	Green House Gas
GJ	Giga Joule
GWh	Gega Watt Hour
HDI	Human Development Index
HHs	Households
HIDCL	Hydroelectricity Investment and Development Company
KWh	Kilo Watt Hour
KWP	Kilo Peak Watt
LED	Light Emitting Diode
LPG	Liquid Petroleum Gas
MoF	Ministry of Finance
Mtoe	Mega Tone Oil Equivalent
MW	Mega Watt
MWp	Mega Peak Watt
NEA	Nepal Electricity Authority
No	Number
NRs	Nepalese Rupees
PJ	Peta Joule (10^15Joules)
PV	Photovoltaic
REEEP	Renewable Energy and Energy Efficiency Partnership
RCC	Reinforced Cement Concrete
SLC	School Leaving Certificate
SWERA	Solar and Wind Energy Resource Assessment in Nepal
TPES	Total Primary Energy Supply
TU	Tribhuvan University
TW	Tera Watt
UNDP	United Nation Development Project
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
Wp	Peak Watt
kWh/ m2	Kilo Watt Hour Per Square Meter

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CHAPTER 1

1. INTRODUCTION

1.1 Background

Energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Uninterrupted energy supply is a vital issue for all countries today. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly. Security, climate change, and public health are closely interrelated with energy. Energy is an important factor in all the sectors of any country's economy. The standard of living of a given country can be directly related to the per capita energy consumption. The recent world's energy crisis is due to two reasons: the rapid population growth and the increase in the living standard of whole societies. The per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation.

The table below indicates the relation between using trend of energy technologies and human civilization.

Table No. 1.1: - Human Civilization and Development of Energy Technology

Energy Resource	Application	Period	
Human	Mechanical Power	About 500,000 Years ago.	
Fire Wood	Domestic use, Craft industry	About 10 to 12 thousand years ago.	
Animal	Agricultural, Transportation, Industry, Replacement of Human Energy	About 10 to 12 thousand years ago.	
Wind	Ship	About 5 to 6 thousand years ago.	
	Agro-processing Mill		
Water	Agro-processing Mill	About 2 to 3 thousand years ago.	
Coal	Steam Engine, Iron and mineral processing	19^{th} century	Industrial revolution
Steam	Transportation, Industry		
Electricity	Cheap Fuels , Industry, domestic all economic and scientific use	End of 19^{th} century and beginning of 20^{th} century.	
Oil			
Gas			
Nuclear			

(Dhakal, 2009)

The energy crisis, which has engulfed Nepal from decades, has been enormous and has largely contributed to the incidence of poverty by paralyzing industrial and commercial activities during this period. It has also resulted in health hazards due to the exposure to carbon emissions caused by constant use of 'firewood, animal dung, coal, Petroleum' in different households and business enterprises, unemployment, and high cost of living leading to a deterioration of living conditions.

Nepal has no known major oil, gas, or coal reserves, and its position in the Himalayas makes it hard to reach remote and extremely remote communities. Consequently, most Nepali citizens have historically met their energy needs with biomass, human labor, imported kerosene, and/or traditional water powered vertical axis mills, yet per capita energy consumption is thus "startlingly low" at one-third the average for Asia as a whole and less than one-fifth the worldwide average. In 2010, Nepal's electrification rate was only 53 percent (leaving 12.5 million people without electricity) and 76 percent depended on fuel wood for cooking (meaning 20.22 million people placed stress on Nepali forests for their fuel needs). This situation has led some experts to call the country's energy portfolio "medieval" in the fuels it uses and "precarious" in the load shedding that occurs throughout Kathmandu, due to an imbalance between electricity supply and demand. Nepal, however, has all it needs to escape these problems. Large markets for improved cook stoves, biogas digesters, and solar lanterns exist throughout the country (UNDP, Nepal Energy Situation by UNDP 2010, 2016).

In the context, there is need of off grid decentralized energy system to increase the access of rural poor to clean energy services particularly in household lighting. The alternative form of energy like solar energy can be the best form of energy in the solution of this problem. The concept of using sun as an energy source is not new; even during ancient times people were using the sun to warm their homes, clothes, food and other. Solar energy can be generated in two forms, namely electricity and heat. Solar cells or "photovoltaic" is used to convert solar radiation into electricity. Photovoltaic systems release no greenhouse gases into the atmosphere and they don't even need direct sunlight to produce energy; they just need daylight and this means they can operate even during cloudy and less bright days.

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

Therefore, this study will mainly concern to analyze; using trend of solar energy and the development of community.

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 community development and plays vital role in increasing and improving the living standard.

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 and climate change, 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.

So in general, this study tried to explain following research questions.

1. What are the main purpose people are using solar energy?
2. Can energy supply play a motivate role to rural life?
3. Is there any ecological and environmental impact arisen due to energy using pattern?

1.3 Objectives of the Study

The main objectives of the study are to identify the possibility and challenges of energy demand and supply which may enhance the economic and social progress in the study area.
The specific objectives of the study area as follows:-

1. To find out the status of the solar energy in the study area.
2. To find out the extent of utilization of the solar technology by the people and assess the energy and other benefits from the installed solar power.
3. To identify the obstacles and challenges of local community for the solar technologies.
4. To suggest the possible effective measures in local context so that the obstacles on utilization of the solar technology can be reduced.

1.4 Significance of the Study

Solar energy becomes the one of believable and long lasting source of energy. In context of Nepal, is suffering energy crises not only due to economic condition but also by geographical condition of our country, with such scenario we must look towards the solar energy as an energy solution of energy trends.

There are tremendous potentials for harnessing solar energy in Nepal, installation of solar energy can be seen as an effective strategy to provide electricity to scattered and isolated rural communities. The establishment of these systems requires considerable initial investment, and therefore justifies the need to evaluate viability and desirability of the solar energy in order to ensure that the resources are utilized.

The study is oriented towards finding out the accessibility of the people to solar energy and role of that technology in improving the quality of life and their living standard. The solar energy is seemed to be one of the alternatives to reduce the crisis of the energy. Our country Nepal is suffering from the shortage of the energy, and the traditional form of energy which is being used since a long time in a rural area is creating a lot of problems either economic or environmental. Such condition seemed to be affecting the socio economic status of people in the negative direction. This study is also to find out the possibility of the solar energy in that area where it is not being used on the basis of the benefits that are being received by the users.

This study might be helpful for the government and the donors to identify as well as to justify that why the solar energy should be given more importance in the context of Nepal for the upliftment of the status of the rural people. The evaluation of these systems will enable the government to formulate adequate policies regarding the promotion of solar energy in particular and development of rural areas in general. Finding of this may be helpful for the government and donors whether to invest in the solar energy is rational or not.

1.5 Limitation of the Study

This research work is completely an academic work and it may not be holistic and detailed one. It may not cover a broad area and ideas as it is limited to Chandragiri Municipality-13 and 14, Machchhegaun of Kathmandu district. Also, due to limited time, finance and knowledge, it may not cover the large area. Following are the limitations in brief.

1. The study is based on only the case study in Chandragiri Municipality ward number 13 and 14, Machchhegaun, thus the application of the study to the whole country may not conclusive.

2. The study is limited to the certain socio-economic impacts and its indicators.

3. Most of the primary data were collected through the semi structured questionnaire relied on recall or the memory of the respondents as they have not recorded data.

4. The study is focused on the secondary data and field study by researcher.

5. Study has conducted with limited time and budget.

1.6 Organization of the Study

The study will be divided into six chapters. First chapter will include introduction, background of the study, statement of the problem, objectives of the study, significance of the study and limitations of the study. Second chapter will be about literature review. In the same way, the third chapter will deal with methodology. It will include rationale for site selection, research design, nature and sources, sampling procedure, techniques and tools for data collection. Similarly, fourth chapter will give overall information about study area which includes introduction of Chandragiri Municipality-13 and 14, Machchhegaun. In fifth chapter there will be the presentation of data analysis. Here, socio-economic status of respondent with their profile and relation between using trend of solar energy and community development is analyzed. Lastly, sixth chapter gives summary, conclusion and recommendation followed by references and questionnaire. Bibliography, interview schedule and checklists have been attached as annexes at the end of the report.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Energy Situation in Nepal

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 (WECS, 2010).

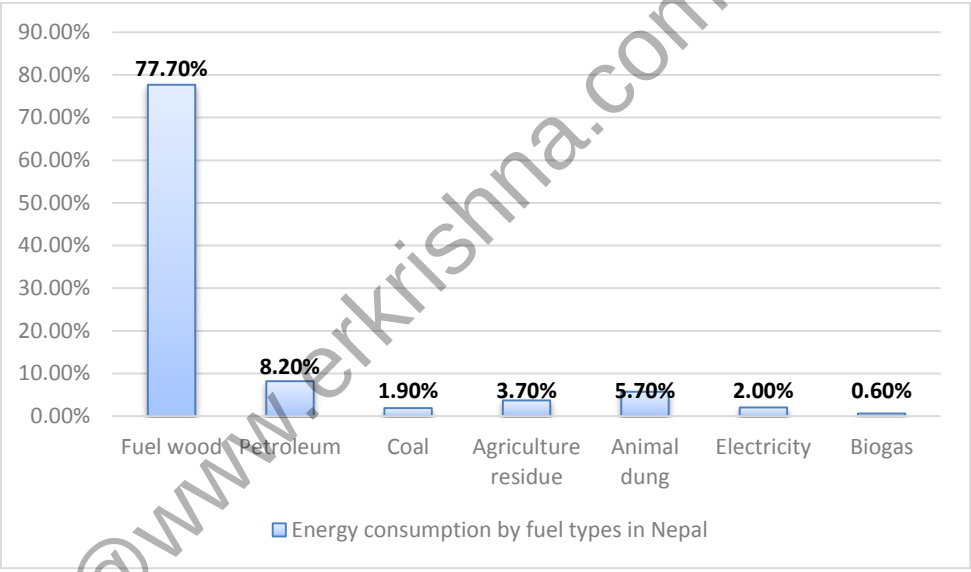


Figure 2.1.1: Energy consumption by fuel types in Nepal (WECS, 2010)

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% (WECS, 2010). 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.

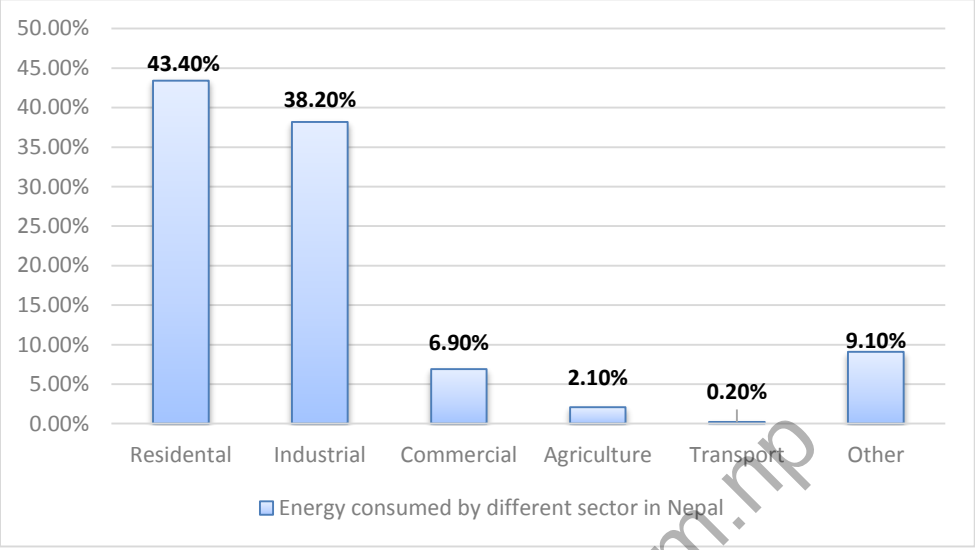


Figure 2.1.2: Energy consumption by different sectors in Nepal (WECS, 2010)

2.2 Concept of Solar Technology

Solar PV cells are semi-conductors devices which absorb solar energy and converted it in to electrical energy. Photons striking the atoms of a semi conducting solar cell free its electrons creating an electric. It was 1st observed on 1839 by Edmond Becquerel. The 1st selenium PV cell was produce in 1883. By 1905, it was known that the number of energy level of electron's emitted by a photosensitive substance varied with the intensity and wavelength of light shining on it.

PV is measured in units of 'peak watts' (Wp). A peak watt figure refers to the power output of the module under 'peak sun' conditions considered to be 1000 watts per square meter. 'Sun hours' or 'insolation', refers to how many hours of peak sun on average exist in different countries.

2.2.1 Photovoltaic (PV) process

The term photovoltaic is derived from the Greek word "phos" meaning light and the word "volt" (named by Alessandro Volta). Photovoltaic is a science, which examines light-electricity conversion, respectively, photon energy-electric current conversion. In other words it stands for light-current conversion. Both direct and diffuse solar radiation takes part of the process. The light to current conversion takes place within solar cells, which can be amorphous, polycrystalline or mono crystalline, according to their structure. In most cases they are made of silicon.

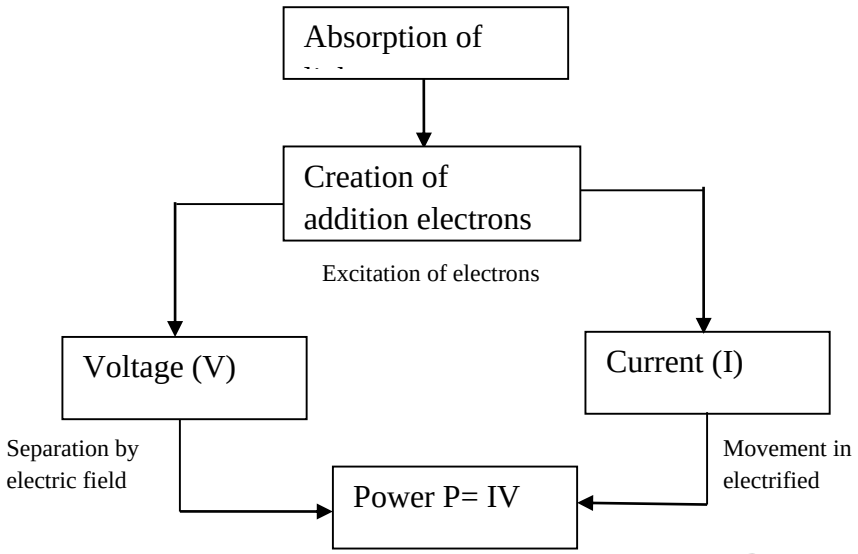


Figure 2.2.1 PV process

a) P-n- Junction: -

Junction diode is formed by placing a p-type crystal in contact with n- type crystal and subjected to high pressure so that it becomes a single piece. The assembly so obtained is called p-n- junction diode. In addition to these majority charge-carriers, there is few minority charge carrier in each region. The p- region contains a few electrons whereas n- region containing few holes. Here the p-type region has (positive) holes as a majority charge carriers and n-type region has (negative) electrons as majority charge carriers.

b) Holes:-

The departure of the electron creates a vacancy valance orbit called holes. It happens when the ambient temperature is above the absolute zero (-273˚c), the heat energy in this air cause the atom in a silicon crystal to vibrate this may result occasionally dislodge an electron from the valance orbit.

c) Energy Gaps:-

In silicon atom, the distance between the valance band and the conduction band is called the energy gap. Where the valance band refer to the amount of energy required to pinch off valance electron from orbit and conduction band refer to the free electron go to next- higher energy band. The relativity few semiconductors found to be close to the optimum energy gap are: -

- Crystalline silicon
- Gallium arsenide
- Cadmium telluride
- Copper indium dieseline
- Amorphous silicon

2.2.1 Types of PV cell

Two main types of silicon cells vie for market share: crystalline and thin film.

a) Crystalline silicon cells are produced by slowly extracting large crystals from a liquid silicon bath. These crystals are sliced into 1/ 100th of an inch thick slices or wafer which are processed into solar cells that are then connected and laminated into solar modules. While this production process yields highly efficient (10-15%) cells, the production process is expensive. Thin film silicon cells are produced by depositing vaporized silicon directly onto a glass or stainless steel substrate. While the efficiencies achieved are lower than with crystalline silicon the production process is less expensive. Module from crystalline cells have lifetime of over twenty years.

b) Thin film modules will last at least ten years. Other PV technologies such as Gallium – Arsenide or Cadmium –Telluride, are also being used. These types are highly efficient, but more expensive at present time.

2.3 Application of Solar Technology

Photovoltaic (PV) cells convert sunlight directly into electricity. So PV module is the base of solar technology. Components of solar technology are listed below

- An array of PV module
- Power conditioning equipment
- Cabling with electrical protection equipment
- Load

2.3.1 Array of PV

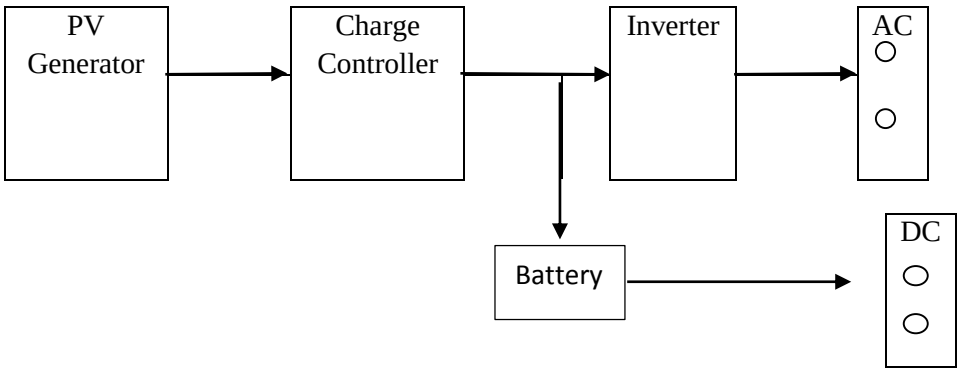


Figure 2.3.1: - PV system configuration

2.3.2 Power conditioning unit

i. Batteries: - Batteries are required when the application requires an electric supply at times when no electricity beings produced by the module. PV batteries must have the abilities to be repeatedly charged and discharge without damage.

ii. Charge controller: - It used to particularly in lead acid batteries. They prevent potential damage in the battery due to overcharging.

iii. Maximum power point tracker: - In electric device usually in corporate in to large PV system. Which automatically adjust module voltage and current to keep the system operating at the maximum power point of current- voltage (I- V) curve.

iv. Inverter: - A solid state electronic component which convert electricity from direct current (DC) to alternating current (AC) for load that require for AC load.

v. Cabling: - Along with electrical overload protective equipment an essential part of PV system and should be specified to last for at least the life time of PV modules.

vi. Load: - the electrical equipments which are operate through electric sucks such as light, iron, radio, television, etc.

The most common end user equipment which operates with a standalone PV power supply can be categories as follows-

a) Refrigerators systems
b) Lightening system
c) Battery charging system
d) Pumping systems
e) Domestic home system
f) Other systems(industry, agricultural, navigational and consumer products)

a) Refrigeration System: - The WHO (World Health Organization) introduce the immunization programmers' with the use of PV powered refrigerator during 1980's in order to maintain vaccines within their required temperature ranger 0 to 8 degree centigrade.

The most common application of PV power refrigerators are:-

- Refrigeration of human vaccines for immunization programs.
- Refrigeration of human blood, live-stock vaccines, domestic refrigerators for remote building.
- Agricultural cold store (few commercial product)
- Ice productions (few commercial product)

b) Lightening system: - in 1970's, small lightening system is 1st widespread application ion PV in developing countries. In term of number of installation, lighting is the presently the biggest application of PV with 10's to 1000's of units installed worldwide and the number is still increasing. They are mainly used to provide lightening for domestic or community building, such as school or heath centers in remote areas. PV lightening is also being increasingly used for security, street and tunnel lightening.

When compare with the traditional lighting equipments currently used by many millions in the rural areas of the developing countries, namely candle of kerosene lamp, PV lighting systems are efficient and provides good quality light with no pollution. They also present no fire risk and do not need constant attention or replacement to their fuel supply.

c) Battery charging system: - The huge demand for small quantities of electricity to small torches, radio, TV, and light on developing countries. This is apparent from the continuous transport of batteries from rural area to network (grid). Connected town the numerous shops offering a battery charging services and vast quantities of small "through-away" prime cells brought by rural peoples.

PV battery charging systems, charging either small rechargeable cells (e.g.-nickel cadmium battery) or slandered lead-acid automotive batteries, can provide an efficient and cost-effective alternative to the extraordinary wasteful procedures followed at present; several thousand are now use in worldwide.

d) Water pumping system: - Initiated on 1970, for application in the Sahal region of West Africa. It can be used to pump from bore holes wells and rivers, the most common application being village water supplies, irrigation and livestock watering.

A PV pumping consists of PV array connected in to an electrical motor deriving centrifugal, reciprocating or diaphragm pump via a power conditioning unit (usually an inverter and a maximum power point tracker). There is no need for batteries because the pump water is used as energy storage.

Depending up on the application and local condition, the 5- general configurations used for pumping system with PV array are-

- Submerge centrifugal motor pump set
- Surface-mounted motor with submerged pump
- Reciprocating positive displacement pump or jack pump
- Floating motor pump sets
- Surface section pumps

e) Domestic home system: - Remote Area Power Supply / Solar Home System are domestic home system which can be as small as a lightening system or large enough to power all the requirements of a grid- connected home. During 1980's the introduction of solid –state technology and energy efficient lamp lead to most cost-effective domestic PV- system and several tens of thousands have now been installed in remote area of developed and developing countries.

A typical system consists of a PV array with batteries, charge regular and various 12to 24v DC appliances for

- Light
- Television, radio and video-recorders
- Fans and ventilation system
- Evaporative coolers
- Refrigerators
- Circulation pump for solar water heating system &
- Computer

f) Other application for the PV

Table 2.3.2:- Other application for the PV

Industrial system	**Agricultural system**
Cathode protection Data acquisition (achievement) Ventilation Air-condition	Electrified fencing Livestock tracking system Drying system (Ventilation fan) Food processing grain grinding, maize shelling) Milk cooling Water tank ice preserve
Navigation lights	**Consumer product**
Street light Coastal light and buoys boat light Trivial avoidance lights (for air-craft) Hazard and directions beacons Railway crossing light	Battery charge for torches Watch, clocks Toys Radio, door bells Car, ventilation
Telecommunication System	**Miscellaneous**
Rural and emergency phones Transceivers Rural radio/ television Board casting system (i.e. mosque)	Water treatment Desalination plants Space heating or water heating/ Heat pump

(Dhakal, 2009)

2.4 Solar Energy as Renewable Energy Sources in Nepal

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 (bioenergy and biofuels), geothermal energy, solar energy, and wind energy.

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 favorable 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 favorable 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 (Pant, 2010).

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 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 =80,000GWh/day = 17.7 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, 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, solar technology may increase the time available to work by allowing people to engage in economic activities even at night.

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 (South Asia Energy Unit, 2010).

2.4.1 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: 2.4.1:- Application of PV power by Sector

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	

(Pant, 2010)

Stand-alone Solar Home System 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 (WECS, 2010).

2.4.2 Yearly installation of solar technology in Nepal

Table No: 2.4.2 Yearly installation of solar technology in Nepal

S.No	Fiscal Year	District	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

(AEPC, 2011)

2.4.3 Number of households by usual type of fuel used for cooking

In Nepal, people use different energy sources for cooking such as electricity, kerosene, bio-gas, solar and others. The energy sources used in rural and urban areas forcooking are listed below.

Table No: 2.4.3

Area/ sources	Firewood	Kerosene	LPG	Cow dung	Bio-gas	Electricity	Others	Not stated	Total
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

(CBS, 2068)

2.4.4 Number of households by usual source of lighting

In Nepal people use different energy sources for lighting such as electricity, kerosene, bio-gas, solar and others. The energy sources used in rural and urban areas for lighting are listed below.

Table No: 2.4.4

Area/sources	Electricity	Kerosene	Bio-gas	Solar	Others	Not stated	Total
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
Nepal	3,647,746	991,510	15,264	403,504	330,170	35,103	5,423,297

(CBS, 2068)

CHAPTER 3

3. RESEARCH METHODOLOGY

3.1 Rationale of Site Selection

The thesis entitled "The Role of Solar Energy on Community Development (A Case Study of Chandragiri Municipality 13 and 14, Machchhegaun, Kathmandu) is selected as a site of this study because of its easy accessibility for data collection. There are different types of people from different caste and ethnic background with different economic and educational status. So the site represent the typical Nepalese community. Largest population in the Machchhegaun is Newars.

There is grid electricity connection in all houses, although due to daily load shedding for several months. Most of the households have been taking significant advantage from solar technology. Recently many people starts using solar geyser for heating water. So the site is appropriate for finding the relation between using trend of solar technology and community development.

3.2 Research Design

The study is based on exploratory and descriptive research design. The purpose of study is to investigate the relation between using trend of solar energy and community development. It has 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.

3.3 Sampling Procedure

For the case study the researcher has selected households that lies in Chandragiri Municipality 13 and 14, Machchhegaun, Kathmandu. In the field survey out of 872 households, 40 respondents from sample HHs have been selected, 38 users of solar electricity and 2 non user's household using semi structured interview schedule. Besides, data required was also collected from public place where solar technology has been used. During the study the researcher has also visited each sample house to acquire the desired objectives.

3.4 Nature and Source of Data

As per the need of the study, more primary and a few secondary data have been collected but priorities has been given to the selection of primary dat. Primary or the first hand data have been collected through the field study adopting various participatory methods like household survey, interview, observation, and questionnaire.

Secondary data have been collected by adopting various secondary means like, different relevant books, journals, reports, institutional publication and website.

3.5 Tools and Techniques of Data Collection

The methods adopted in the study to generate relevant data have been guided by research objectives, questions and the type of data required for the study. Following techniques have been adopted to collect primary data:

3.5.1 Interview through household questionnaire:

To obtain the primary data face to face interviews have been conducted, where the researcher directly talked to the respondents to know the fact of the use and impact of solar energy. It involves interaction between interviewer and respondents. The researcher has included different types of questions like, general information, information about past, present and future use of solar energy, its impact, and changes in life.

3.5.2 Case study

This method has been used to explore the life pattern, activities and life history of the respondent. The case study has supported to get immense information about using trend of solar energy on community and its impact on community development.

3.5.3 Informal interview

During field study, informal interactions with a number of people have been made. They have been asked about use of solar energy in their daily life. Some of them have been asked about the use of solar energy in public places and its impact.

3.5.4 Field note

It is almost impossible to remember all the information collected during the field survey therefore field note has been recorded to remind later. During field survey both subjective interpretation of the situations and the raw interpretation of the fact have been recorded.

3.6 Data analysis and interpretation

A work sheet has been prepared through the complete questionnaire. The collected data have been classified according to its nature and characters. To make the analysis more reliable and easier, different data sheets have been prepared for different variable. Field questioner is carefully checked for possible errors. The data is carefully edited and processed by computer programs then the required conclusion, pie-chart, bar diagram and table is generated.

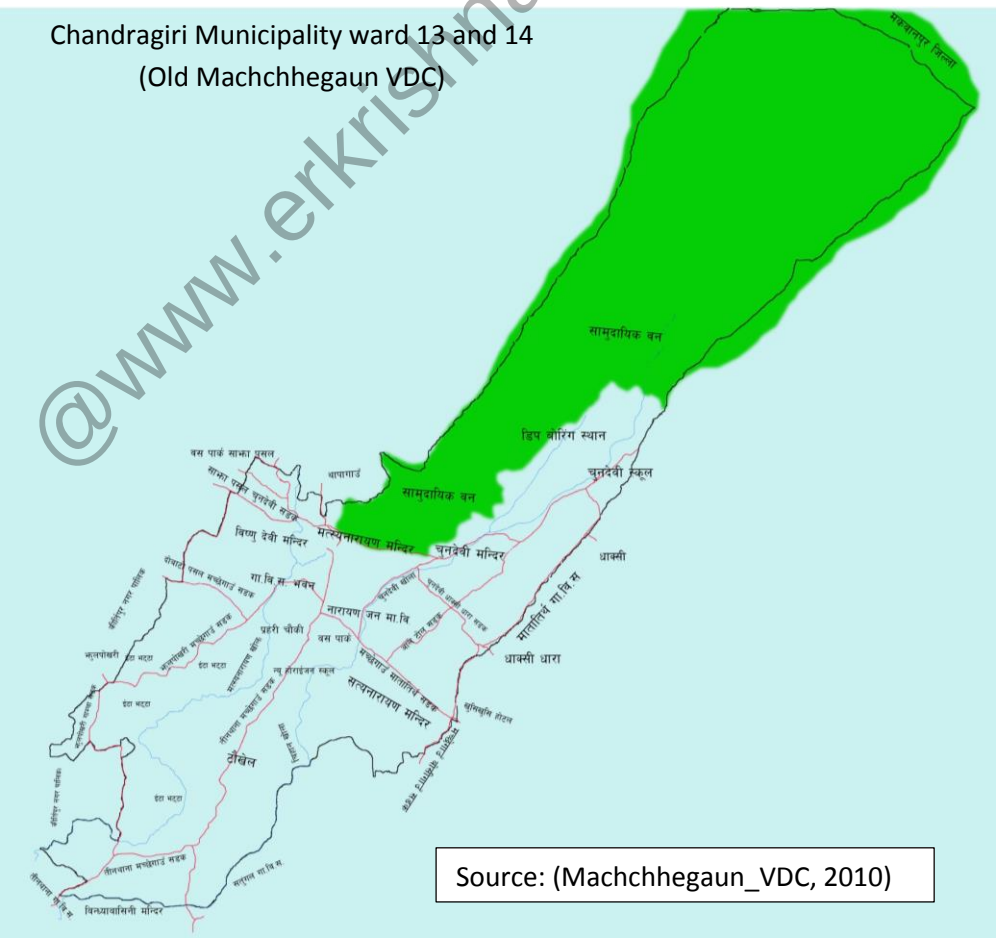
CHAPTER 4

4. GENERAL INFORMATION OF THE STUDY AREA

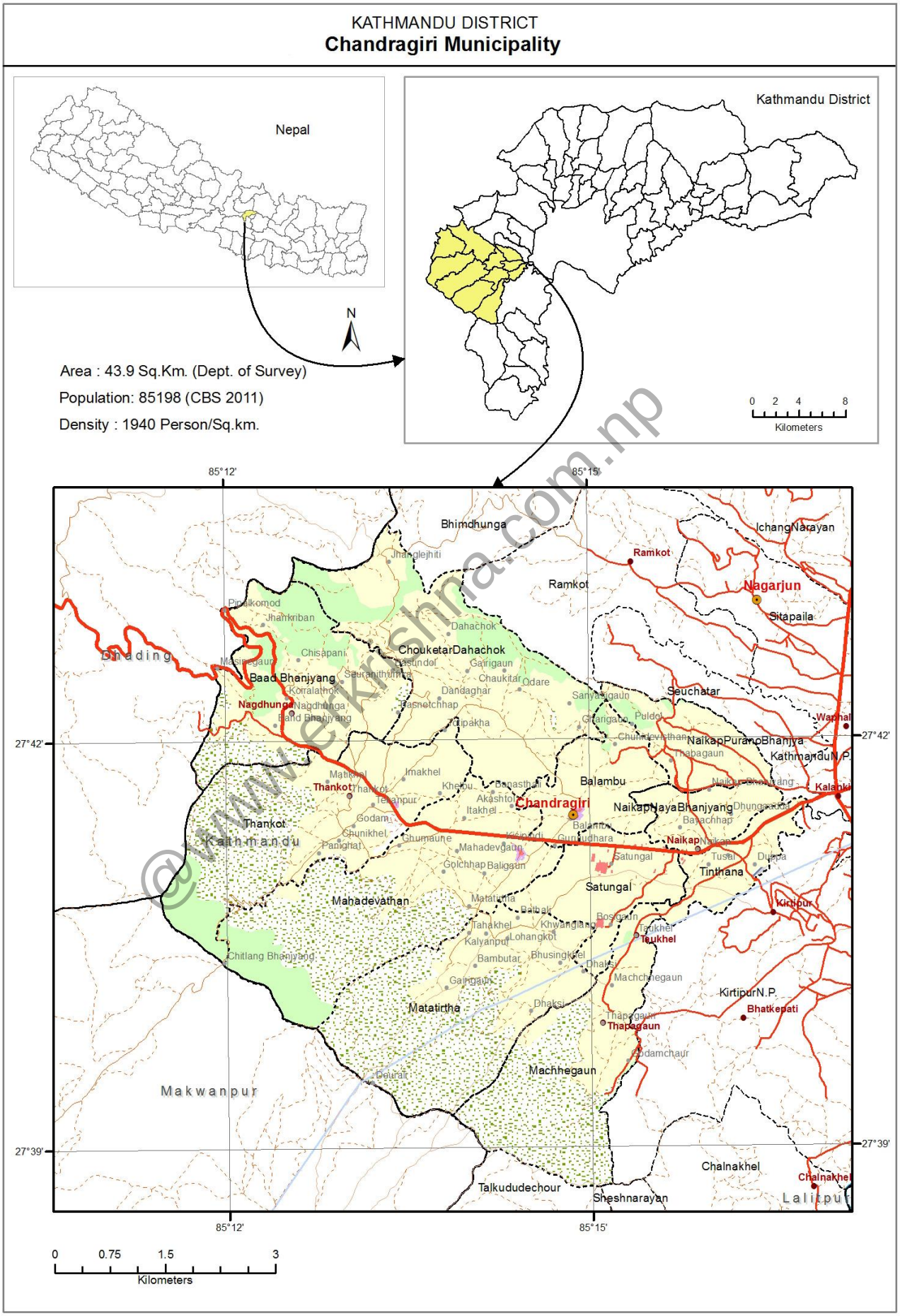
4.1 Introduction of Study Area

Chandragiri is a Municipality in the Central development region of Kathmandu District in the Bagmati Zone of Nepal. The new municipality was formed by merging eleven existing villages- Baad Bhanjyang, Balambu, Dahachok, Mahadevsthan, Machchhegaun, Matatirtha, Naikap Naya Bhanjyang, Naikap Purano Bhanjyang, Satungal, Thankot and Tinthana on 02 December 2014 (Chandragiri_Municipality, 2016).

This study is carried out in Machchhegaun, ward no. 13 and 14 of Chandragiri Municipality, Kathmandu district. Machchhegaun lies at the south western part of the Kathmandu valley. There are 872 HHs covering 3849 population in the Machchhegaun. It is 9 km away from center of Kathmandu District Development Committee Office requiring 1 hrs. traveling distance by road bus (Machchhegaun_VDC, 2010).



Map 4.1.1 Machchhegaun VDC (Chandragiri Municipality ward 13 and 14)



Map 4.1.2 Chandragiri Municipality

4.1.1 Climatic record of Machchhegaun

Latitude: - 27°39’40’’N to 27°40’51’’N Longitude:- 85°14’20’’E to 85°15’45’’ E
Altitude: 1600m to 2000m
Maximum Temperature 36°c Minimum Temperature 2°c
Rain fall (average in a year) 1764.4 mm
Average Annual Relative Humidity: - Maximum 90 and minimum 40
Source: (Machchhegaun_VDC, 2010)

4.1.2 Demographic trends of Machchhegaun

The summarized demographic data of Machchhegaun is shown below.

Table No. 4.1.2:- Population distribution of Machchhegaun

S.No	Particulars	20011 Census
1	Total population	3849
2	Male	1884
3	Female	1965
4	Sex ratio	96
5	Total households	872
6	Average household Size	5
7	Literacy Rate in %	59.35
8	Population Density per Sq. Km.	2.413

(CBS, 2068)

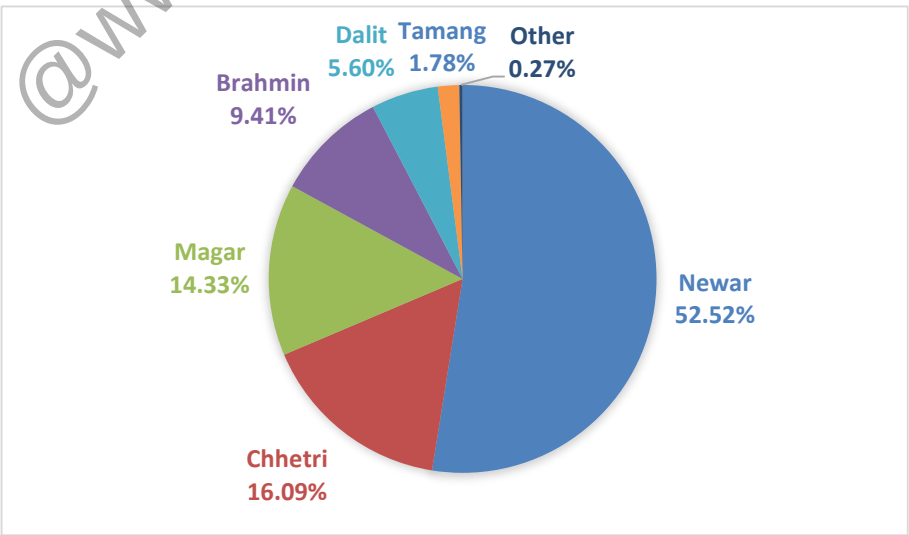


Figure 4.1.2: Ethnicity/caste composition of Machchhegaun
Source: (Machchhegaun_VDC, 2010)

4.2 Infrastructure and Social Services of Machchhegaun

Some remarkable social development and updated infrastructure situation of the Machchhegaun is mentioned as follows in table.

Table 4.2: - Infrastructures and Social Services of the Machchhegaun

S.No	Descriptions	Quantity
1	Primary Schools	1
2	Secondary School	2
3	Guthi	35
4	Cooperatives	11
5	Post Office	1
6	Sub health post	1
7	Bus park	1
8	Temples	24
9	Public Building/Falcha (Pati)	21
10	Public places/ grounds	31
11	Public water sources	17
12	Public water tanks	6
13	Non-governmental Organization	25
14	Library	1
15	Shops	46
16	Hotels	27
17	Cosmetic and Clothes Shop	13

Source: (Machchhegaun_VDC, 2010) and Field Survey 2016

4.3 Occupational Status of People in Machchhegaun

Occupation determines the household's wealth, well-being, literacy status and social stigma in society which plays a vital role in the energy consumption pattern. The occupational status of people in Machchhegaun is shown in figure 4.3 below.

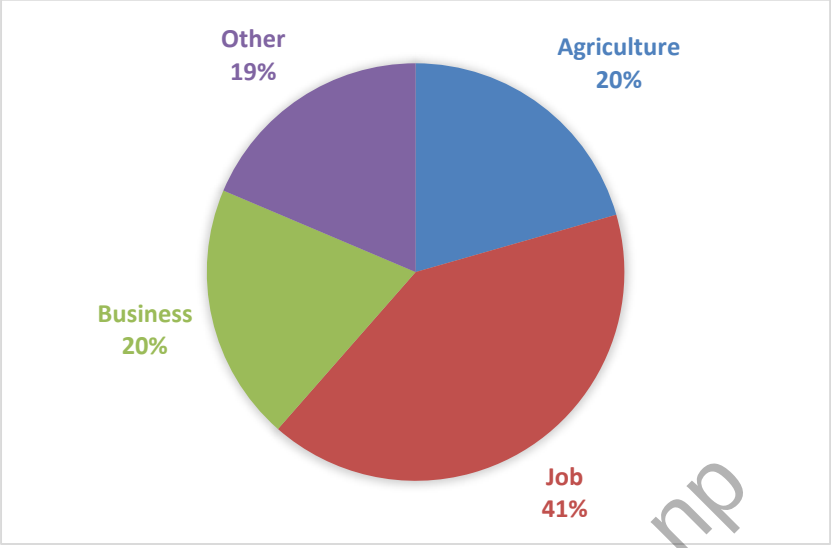


Figure 4.3:- Occupational Status of People in Machchhegaun
Source: (Machchhegaun_VDC, 2010)

4.4 Literacy Rate of the People in Machchhegaun

According to the VDC profile 2010, the educational scenario of local resident in Machchhegaun among the young population (16 to 44 years old) is about 59.35%, which reflect that Machchhegaun is ongoing towards the progressive on education. The table below shows the educational status of the people in Machchhegaun.

Table 4.4:- Educational Status of the People in Machchhegaun

S.No	Level	No. of Population		Total	Percentage (%)
		Male	Female		
1	Under SLC	405	409	814	47.46356
2	SLC	220	159	379	22.09913
3	Under Graduate	173	166	339	19.76676
4	Graduate	100	49	149	8.688047
5	Post Graduate	30	4	34	1.982507
Total		928	787	1715	100

Source: (Machchhegaun_VDC, 2010)

CHAPTER 5

5. INTERPRETATION AND ANALYSIS OF DATA

5.1 Status of People in Sample HHs

The sample households (HHs) is taken from Machchhegaun (Chandragiri Municipality Ward no. 13 and 14), which is composed of different ethnic groups. Largest population in the Machchhegaun is Newars. Besides, the other castes and ethnicities like Brahmin, Chhetri, Magar, Tamang and Dalit have their considerable presence. The religion of the people is Hindu, Buddhist and Christens.

Most of the houses have RCC, zinc and slate thatched roofs. The wall of the house is made by RCC, Bricks, 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.

5.1.1 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 in table below.

Table No.5.1.1:- Ethnicity/Caste composition of the sample HHs

S.No	Ethnicity/Caste	No. of HHs	Percentage (%)
1	Newar (without Newar Dalit)	28	70
2	Brahmin/Chhetri	6	15
3	Magar/Tamang	3	7.5
4	Dalit	3	7.5
Total		40	100

Source: Field Survey 2016

5.1.2 Occupational status of the sample HHs

On the basis of major occupation in the study area, the households engaged in Agriculture, Job and Business has been shown below.

Table No. 5.1.2:- Occupational status of the sample HHs

S.No	Source	No of HHS	Percentage (%)
1	Agriculture	12	30
2	Job	19	47.5
3	Business	9	22.5
Total		40	100

Source: Field Survey 2016

5.1.3 Household size of sample HHs

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 in table below.

Table 5.1.3:- Distribution by the households size of the sample HHs

S.No	Family size	No of HHS	Percentage (%)
2	less than 4	6	15
3	4 to 7	30	75
4	more than 7	4	10
Total		40	100

Source: Field Survey 2016

5.1.4 Monthly income of sample HHs

The income of the households is crucial factor that determines the people's way of living and their socio economic status, 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 and Business. The different common monthly income range of sample household is shown in table 5.1.4 below.

Table No 5.1.4:- Monthly income of sample HHs

S.No	Monthly income range	No. of HHs	Percentage (%)
2	less than 10000	2	5
3	10000-30000	27	67.5
4	above 30000	11	27.5
Total		40	100

Source: Field Survey 2016

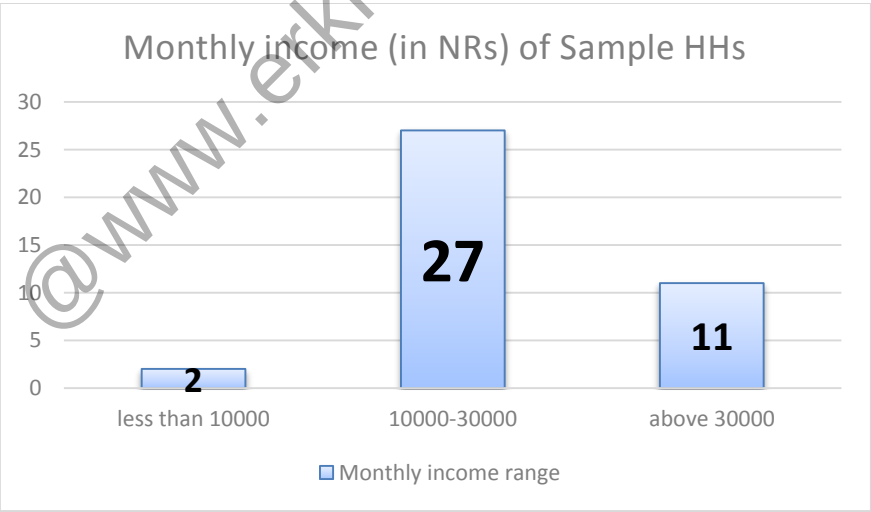


Figure 5.1.4:- Monthly income of sample HHs

Source: Field Survey 2016

5.2 Energy Use Situation in Sample HHs

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.

The monthly expenses on energy consumption from different source of energy and renewable energy use situation in sample HHs are listed in table below.

Table No: 5.2 Monthly Expenses on Energy Consumption in Sample HHs

S.No	Type of source	Expenses Rs (Monthly)
1	Petroleum/Fuel wood/ Other	2062.5
2	Electricity From NEA	543.75
3	Renewable (Solar /Wind)	0
Total		2606.25

Source: Field Survey 2016

5.3 Renewable Energy Use Situation in Sample HHs

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. The commonly used renewable energy in sample households in Machchhegaun is listed below.

Table No: 5.3 Renewable Energy Use Situation in Sample HHs

S.No	Type of Renewable Energy	No. Of HHs	Percentage (%)
1	Electricity From NEA	40	100
2	Solar	38	95

Source: Field Survey 2016

5.4 Use of Solar Technology in Sample HHs

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 concept of using sun as an energy source is not new; even during ancient times people were using the sun to warm their homes, clothes, food and other. Solar energy can be generated in two forms, namely electricity and heat. Solar cells or "photovoltaic" is used to convert solar radiation into electricity.

People use solar energy for different purpose using different solar technologies which is shown in tables below.

Table No. 5.4.1:- Purpose of solar energy in sample HHS

S.No	Purpose of Solar Energy	No. Of HHs	Percentage (%)
1	Cultivation	40	100
2	Lightening	37	92.5
3	Heating Water and other	6	15

Source: Field Survey 2016

Table No. 5.4.2:- Type of solar technology used in sample HHs

S.No	Type of Solar Technology	No. Of HHs	Percentage (%)
1	Solar Panel	38	95
2	Solar Geyser	4	10
3	Both 1 and 2	4	10

Source: Field Survey 2016

5.5 Distribution of Solar Technology by Date of Installation in Sample HHs

Households of Machchhegaun have installed solar technology in different years, which are shown in table below:

Table No 5.5 Date of Installation of Solar Technology by Year

S.No	Year of Installation	No. of HHs	Percentage (%)
1	More than 5 years ago	6	15.79
2	Less than 5 years ago	20	52.63
3	Recently	12	31.58
Total		38	100

Source: Field Survey 2016

The above table shows that only 15% use solar technology before 2067 and the users are increased by 52% in next 5 years and it is increasing day by day.

5.6 Distribution of Solar Technology by system Size in Sample HHs

Different households use solar technology of varying capacity from 9Wp up to hundreds of Wp capacity considering their capacity and energy needs. The various sizes of the systems installed in sample households in Machchhegaun are shown in table below.

Table No. 5.6:- Distribution of Solar Technology by system Size

S.No	Size of the System (Wp)	No. of HHs	Percentage (%)
1	less than 20W	6	15.78947
2	20W-100W	28	73.68421
3	More than 100W	4	10.52632
Total		38	100

Source: Field Survey 2016

5.7 Solar Technology in Public Places

In Machchhegaun many public places using solar technology as alternative source of power supply for various purpose which motivate the other general people towards the use of solar technology. This shows the increasing use of solar technology in the community. The places and capacity of solar technology used in various public places are listed in table below.

Table No 5.7:- Solar Technology in Public Places

S.No	Place	Capacity	Remarks
1	Vishnu Devi Temple	40W	4 LED lights are used
2	Machchhenarayan Temple	20W	2 LED lights are used
3	Street Lamp	1200W	12 street lamps in different places powered from single solar system
4	New Horizon Academy	1000W	Official use

Source: Field Survey 2016

5.8 Benefit from Solar Technology

In Machchhegaun, people generally use LPG Gas, Electricity, and Firewood as sources of cooking fuel. Candles and Tukis (Fuel Lamps) were used for lighting before the rechargeable lights were introduced but after solar technology most of the households use it as alternative source of light.

There is grid electricity connection in all houses, although due to daily load shedding for several months. Most of the households have been taking significant advantage from solar technology. Recently many people starts using solar geyser for heating water. The major benefits of solar technology are described below.

5.8.1 Social benefits

The solar technology user believe that their social life standard becomes higher after using it. The light coming from kerosene powered tuki or candle was not bright enough, smoky, and risky and causes headaches for children to study. The rechargeable lights have also less life and high operating cost. After use of solar technology, people get clean, bright and non-smoky light and healthy environment.

Similarly, people save time required to search fuel wood and petroleum for lightning and cooking. Beside this people perform different household's activities in solar lights more comfortably.

5.8.2 Economic benefits

Among the various economic benefit, one of the important economic benefit is it saves the money for kerosene, torch light batteries and electricity bills, which helps to boost the economic condition not only of the households but of the entire country. The money paid for importing petroleum products has been reduced by solar technology and helps to reduce the trade deficit.

The time and money saving by the solar technology in sampled household is given in table below.

Table No 5.8.2: - Time and money saving by solar technology

S. No	Purpose	Energy source	Before Solar Technology		After Solar Technology		Saving by Solar Technology	
			Time in Hour (monthly)	Expenses in NRs. (monthly)	Time in Hour (monthly)	Expenses in NRs. (monthly)	Time in Hour (monthly)	Expenses in NRs. (monthly)
1	Tuki / Candle	Petroleum	4.9	395	0.45	25	**4.45**	**370**
2	Electric light	Battery	5.475	141.25	4.575	79.75	**0.9**	**61.5**

Source: Field Survey 2016

5.8.3 Environmental benefit

One of the most important benefits of solar energy is that it is renewable energy and doesn't release any harmful carbon dioxide (CO2) and other pollutants. Similarly, 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.

5.8.4 Health benefits

The respiratory diseases, headache, and fire hazard due to smoke of fire wood and fuel lamp won't be there in solar lights. So people are not suffering from health hazards due to their daily lightening and cooking activities.

5.9 Major Problems Faced with Solar Technology

The initial cost of solar technology 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. The households who are using the solar technological system getting constraints due to non-viable of technician on the spot at the time of requirements, due to this they are paying high cost at a time of installation and maintenance.

CHAPTER 6

6. MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Major Findings

Following are some of the highlights of the key findings:

- There are 872 households covering 3849 population in the study area, Chandragiri Municipality ward no. 13 and 14, Machchhegaun, Kathmandu.
- Among 40 sample households, 38 households has been taking advantage from solar technology.
- Highest no of households in the study area are Newars (70%) followed by Brahmin/ Chhetri (15%), Magar/ Tamang (7.5%) and Dalit (7.5%).
- Major occupation status of the sample households, job 47.5%, agriculture 30% and business 22.5%.
- The study area has maximum households size of 4 to 7 members.
- 67.5% sample households has their monthly income range NRs. 10000 to NRs. 30000 which supports their monthly expenditure well.
- Monthly average expenses on energy consumption in sample households for Petroleum/Fuel wood/ other is NRs. 2062.5 and for electricity (NEA) is NRs. 543.75.
- 95% of sample households use solar technology as an alternative source of renewable energy and 100% use electricity from national grid line (NEA).
- All sample households uses solar energy for taking sun bath and cultivation, 92.5% use for lightening and 15% uses for heating water.
- 95% of sample households use solar panel and 10% uses both solar panel and solar geyser.
- 15.79% of sample households are using solar technology from more than 5 years ago, 52.63% are using from less than 5 years ago and 31.58 % installed it recently.
- 20w to 100w solar panel is the most popular in the study area used by 73.6% (28 households), 15.8 % (6 households) has installed less than 20W and lowest household about 10.5 % (4 households) has installed more than 100 w solar panel system.
- Many public places like temples and schools are using solar technology as alternative source of energy.
- After the installation of solar technology each households save monthly 4.45 hour time on searching for lightening petroleum and average NRs 370 on buying it. People also save time and money on buying batteries and electricity about NRs. 61.5 monthly per households.

- By using solar technology people totally stopped using petroleum for lightening and rechargeable batteries are also less in use for lightening.
- By using DC system people are able to fulfill their need with minimum watt of solar technology.

6.2 Conclusion

People are using energy to their ever part of life by knowingly or unknowingly since the origin of human life. The main purpose of energy use is for sustain life. People are using solar energy, wind energy since their evolution, later they know the uses of fire and they invent other form of energy sources like petroleum, gas, coal and many more. The study is mainly focused on the using trend of solar energy and its impact on community development since, people are using solar energy from their existence. The sample households is taken from Machchhegaun, which is composed of different ethnic groups. The average family size of household is 4 to 7. And the majority of the population was from medium class of family in respect of income, education and occupation. But the trend of using solar energy is changing and increasing generation to generation along with the development of community.

The present world demands excess amount of energy which is impossible to fulfill without increasing the use of renewable energy sources. The solar photovoltaic system is emerging as a renewable alternative energy source not only for lighting but also for various purposes. By the promotion of the solar energy 38 sample households and 5 public places of Machchhegaun had been benefited from the cleaner, brighter and smokeless light that has saved monthly 4.45 hour time on searching for lightening petroleum and saved average monthly expenses of NRs 370 on buying it. People also save time and money on buying batteries and electricity about NRs. 61.5 monthly per households. The more significant role played by the installation of solar technology carried on lighten purpose, about 92.5% of households are using solar technology as alternative source of light. Similarly, for heating water about 15% of households are suing solar technology.

In near future more and more solar technology will use for various types of services. There is a plan under consideration to install solar technology in ward office and many solar technology non users are also planning to install soon. These facts indicate that time has come to pay special attention for solar technology for sustainable and clean energy development. So the people and government should play significant roles on achieving the goal of development however the roles differ from one another. For the utilization of solar energy through solar technology, the main role of the government to make accessibility of the equipment provides sufficient amount of technocrats, making adjustable policy for interested private sectors and making subsidy for solar technology.

It is undoubting fact that, the solution of energy demand for coming generation is not be solve on ignoring the role of solar technology.

In conclusion increasing use of solar energy has helped people to boost their living standard, prestige and overall development of their lives and make them self-reliant which certainly plays crucial role in reducing the poverty and in community development.

6.3 Recommendations

As already mentioned above that solar technology is a wiser and most appropriate solution for lighting where shortage of electricity is common problem. Based on the study following recommendations are made for its wider applications throughout the nation.

- Government should run campaign to make people aware about solar technology, as using solar technology for lightening is more effective when it is used as DC supply system.
- Skilled technicians, repairing centers and shops for buying and repairing different components of solar technology should be made available within the locality.
- The initial cost of installing solar technology is high such that all people can't support it. So subsidy should be increased for the promotion of renewable clean energy.
- Beside subsidy government should provide incentives in imports and transportation of components of solar technology system rather than providing incentives to petroleum.
- 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.
- Government should make policy on commercial production of solar energy and provision of selling it to the grid connection.

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Interview Schedule

Questionnaire

Confidential, Information to be used for Research Purposes only

The Role of Solar Energy on Community Development
(A Case Study of Chandragiri Municipality 13 and14, Machchhegaun, Kathmandu)

Respondent No. ……
Name of Respondent: ……. Age: …. Sex : F/M
Address: ……
Native Language: …… Occupation: ……
Date of interview: ……

(A) Demographic/ Economic

1. How many members are there in your family?
   a) Less than 4
   b) 4 to 7
   c) More than 7

2. What is the monthly income of your family?
   a) Less than NRs 10000
   b) NRs 10000 to NRs 30000
   c) More than NRs 30,000.00

3. Which of these renewable energies you are using in your daily life?
   a) Hydro-power
   b) Solar
   c) other (wind, bio gas)

4. How much energy is consumed in your house?

Type	Monthly Expenses (NRs)
Petroleum / Fuel wood/ other	
Electricity from NEA	
Others (Solar/Wind) operation cost only	

(B) Use of solar Energy

5. For what purpose you are using solar energy?
   a) Irrigation & cultivations only
   b) For lightening
   c) For heating water and other

6. Do you and your family take sun bath during winter season?
   a) Yes b) No

7. Do you know electricity can be generated from sun?
   a) Yes b) No

8. Which of these solar technology are you using?
   a) Solar panel
   b) Solar geyser
   c) Both a and b

9. Since, when you are taking advantage from solar energy as electricity?
   a) More than 5 years ago
   b) Less than 5 years ago
   c) Recently

10. What is the installing capacity of solar electricity at your home?
    a) Less than 20 watt
    b) 20 to 100 watt
    c) More than 100 watt

11. What is the installation cost of your solar technology at your home?
    a) Less than NRs. 10,000
    b) NRs. 10,000 to NRs. 25,000
    c) More than NRs. 25,000

12. Do you feel the solar technology is more expensive rather than other?
    a) Yes b) No

13. Did you get any subsidy from the Government / Non-government organization?
    a) Yes b) No

14. Has it brought any difference in your daily life for working hours?
    a) Yes b) No

15. Do you feel your social standard becomes high after using solar technology?

a) Yes b) No

16. Monthly expenses of energy and time for the household for lightening before and after use of solar technology?

S. N.	Purpose	Types of energy sources	Cost of energy consumption (NRs)		Required time to collect, in hour (*30)	
			Before	After	Before	After
1	Lighting	Tuki or Candle				
2	Electric Light	Battery				

17. Has the expenditure on your health reduced after using solar energy as an electricity?

a) Yes b) No

18. Do you have any suggestions about use of solar energy for development of community?

……

……

Thank you! For providing your valuable time and information.

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Information about Solar Technology used in Public Places

S.No	Place	Capacity (Wp)	Remarks

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Photographs

Photo: People of Machchhegaun using Solar Panels and geyser at roof top of their house

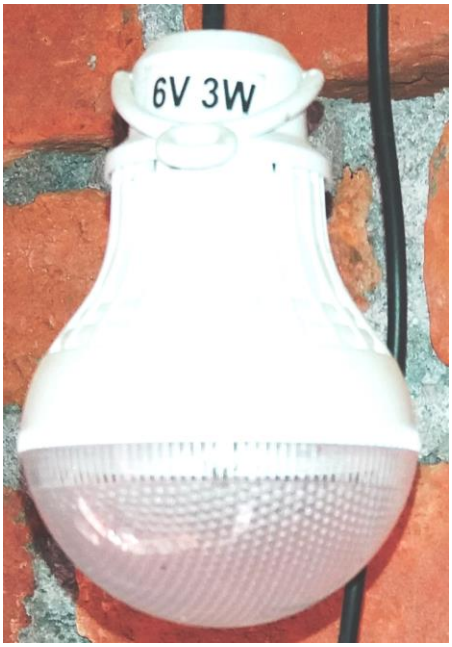

Photo: 9 watt, DC lightning, solar system