

HOUSEHOLD COOKING FUEL IN RURAL SIKKIM

Abstract

DOCTOR OF PHILOSOPHY

DEPESH SUBBA



**Centre for the Study of Regional Development
School of Social Sciences
Jawaharlal Nehru University
New Delhi-110067
2019**



जवाहरलाल नेहरू विश्वविद्यालय
JAWAHARLAL NEHRU UNIVERSITY
Centre for the Study of Regional Development
School of Social Sciences
New Delhi-110067

Date: 19.07.2019

DECLARATION


I, **DEPESH SUBBA**, hereby declare that the thesis entitled “**HOUSEHOLD COOKING FUEL IN RURAL SIKKIM**” submitted by me for the award of the degree of **DOCTOR OF PHILOSOPHY** is a bonafide research work and that it has not been submitted so far in part or in full, for any degree or diploma of this university or any other university.

DEPESH SUBBA


CERTIFICATE

It is hereby recommended that this thesis be placed before the examiners for evaluation.

Prof. Sachidanand Sinha
(Chairperson)

 Chairperson
Centre for the Study of Reg. Dev.
School of Social Sciences
Jawaharlal Nehru University
New Delhi - 110067

Prof. Dipendra Nath Das
(Supervisor)

 Centre for the Study of Reg. Dev.
School of Social Sciences
Jawaharlal Nehru University
New Delhi - 110067

Acknowledgement

The long journey of PhD would not be possible without my supervisor Prof. Dipendra Nath Das for his guidance. He helped me to grow as a person- academically. His advice/guidance will always remain intact in my life for which I shall remain always grateful. The journey with you won't end here; I will always cherish and hope for your valuable guidance in future. I am also grateful to Prof. Shrawan Kumar Acharya for his advice – at academic and personal level. I also like to thank entire JNU family especially my centre: Centre for the Study of Regional Development (CSR-D-SSS-III) and its entire professors, non-teaching staffs for their countless help. I am always grateful to Jawaharlal Nehru University (JNU) and hostel mates/staffs of Chandrabhaga and Bhramaputra hostel. I am also thankful to various departments of the Government of Sikkim for their help. It would not be possible to complete my PhD without sincere cooperation from our people- all the respondents from study area (rural Sikkim)-Thank you all.

Ohh my family...!!! Hats off to you all. I'm blessed to have a coolest family - Aama, Papa, Anju Di, Manju Di, Pushpa Di, Deven. I am fortunate/grateful and proud to have supporting parents: my *Aama* Ganga Devi Subba and *Papa* Laxuman Subba, they valued education above all. I miss u papa- my hero, my inspiration. I am equally indebted to have coolest and *pyaro didi* like Anju, Manju, Pushpa and *bhai* Deven. Their constant guidance shaped me to grow as a person. It is your sheer effort which made me to pursue PhD without letting me realizing my responsibility-thank you all for compensating. My family is my strength and a constant source of inspiration.

I am fortunate to have a universe size family:

Parents:

Laxuman Subba, Ganga Devi and Pushpa Subba (thulo aama)

Siblings

Bejoy da- *bhawju* Ganga Subba; Niru da- *bhawju* Meera Subba, Sushila (kanchi Di- *veena* Raaj Chettri), Dhiren da (*Kancha da- bhawju* Dimple Subba), Archana (*maili Di- veena* MB Limbu), Anju Di- *veena* GB Subba) Aruna (*Saili Di- veena* Ashok Pradhan), Manju Di, Sujana (*kattu Di- veena* Parash Subba), Pushpa Di- (*veena* Ajay Rai), *pyaro bhai* Deven.

GenNext

Sarina, Tufan, Arunika (*bainee*), Prajwal, Diksha-Dristri (Dolly-Polly), Shidharth, Divyam, Anmol, Sishir, Nityam, Grishma Hang (Gorey da), Anura.

LOVE YOU ALL.

My teachers from Geography Department, Sikkim University have an influential role in my life especially Dr. Manoranjan Mishra Sir for his guidance- I own my success to you. My sincere gratitude to Dr Uttam Lal, Dr Rafael Ahmed, Dr. Sohail Firdos, Dr Ishwarjit Sir for their valuable inputs.

I am also thankful to some people for their valuable support in my life.

A special mention to Jocelyn Susanna Rai - Thank You 'joce'.

How on earth I can forget to mention some of my crazy friends? Literally, I am blessed to have a group of naughtiest friends (Gangatians 'crabs') - Barun, Phigu, Sonam, Sujan, Tamding, Ugen.

I am lucky to meet my classmates (CSR Dian-2012) from diverse backgrounds: Anita, Archana, Awanti, Bhawana, Debarshi, Dishya, Hijam (kanan), Homolata, Jayanta, Jogi *baba*, Komal da, Mehbub, Pritika, Prakriti, Rajni, Rakesh *baba*, Tek Chand (Teka baba), Shreshtha, Veenet. I am always thankful/grateful to Rakesh Mishra, Ramesh, Komal da, Tek Chand Saini and Bailochan Behera for their valuable academic inputs.

Thank you to all the members of Sikkim Students Association (SSA-JNU). I am very much fortunate to meet friends/juniors seniors like Sonam da, Sailendra da, Rabindra da, Sunil da, Pravhat da, Tashi bhai, Garjamaan, Palzor, Ananta-Manisha di, Sanjay-Karma bhai, Namu, Nares, Rinzing, Issac.

I would like to thank my friends from School, College and Masters days. I am very fortunate to have friends like Karma Detsen Ongmu Bhutia (my sincere cadet), Salina, Awanti, Priyanka, Bishal, Bala, Ranjan Karmakar, Lakshmi Chongbang (Subba) - for their constant support.

Thank You All. Proud to be a JNUiets

CONTENT

Acknowledgement.....	i
List of content.....	iii
List of tables.....	vii
List of figure.....	x
List of maps.....	x
Abbreviation.....	xi

CHAPTER 1: INTRODUCTION.....Pg.No-1-8

1. Introduction
2. Global agreements to curb climate change
3. Sustainable Development Goal (7): Ensure access to affordable, reliable, sustainable and modern energy for all
4. Energy at glance
5. Access to clean and modern energy and development
6. Two major models on household cooking fuel
 - 6.1. Energy ladder model
 - 6.2. Multiple energy model

CHAPTER 2: LITERATURE REVIEW.....Pg.No-9-30

1. Global scenario
2. Indian scenario
3. Changing national policies on household cooking fuel
4. Biomass as cooking fuel and its implications
5. Factors affecting of household cooking fuel
6. Firewood as fuel in mountain areas
7. Policy measures

CHAPTER 3: STUDY AREA AND CONCEPTUAL FRAMEWORKPg.No-31-58

1. A historical journey of Sikkim
2. The Chogyal Dynasty of Sikkim
3. Physical and climatic setting of Sikkim
4. Administrative set up
5. Demographic and socio-economic profile of Sikkim
 - 5.1 Demographic profile
 - 5.2. Agriculture
 - 5.3. Literacy
 - 5.4. Rural area
 - 5.5. Urban area
 - 5.5.1. Size, Class and status of Towns
 - 5.5.2. Municipalities

- 5.5.3. Tourism
- 6. Forest and environment
- 7. Major forest and environment policies in Sikkim, since 1995
- 8. Policies on energy sector in Sikkim
 - 8.1: Sikkim Renewable Energy Development Agency (SREDA)
 - 8.2: National Biogas and Manure Management Programme (NBMMP) in Sikkim
 - 8.3: Biogas plant
 - 8.4. Provision of LPG and kerosene distribution system in Sikkim
- 9. Research gap
- 10. Statement of problem and need of the study
- 11. Conceptual framework
- 12. Objectives
- 13. Research questions
- 14. Study area
- 15. Sampling methods
 - 15.1. North district
 - 15.2: East district
 - 15.3. West district
 - 15.4. South district
- 16. Methods
 - 16.1: Statistical methods

CHAPTER 4: SOCIO-ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF STUDY AREA (RURAL SIKKIM)..... Pg.No.59-95

1. Introduction

2. Study area and sample size of study area (Rural Sikkim):

3. Sample villages and their background:

3.1. East District:

- 3.1.1 Assam Lingchey
- 3.1.2. Pacheykhani (Dikling)
- 3.1.3. Subanedaran

3.2. South district:

- 3.2.1. Rong
- 3.2.2. Chuba
- 3.2.3. Bermoik

3.3. North District

- 3.3.1. Lachen
- 3.3.2. Shipgyer
- 3.3.3. Namok

3.4. West District

- 3.4.1. Gerethang
- 3.4.2. Chakung
- 3.4.3. Karthok
- 3.4.4. Mabong

4. Household cooking fuel use in rural Sikkim

5.. Socio-economic and demographic profile of the study area:

- 6.. Household characteristics associated with fuel use:
7. Primary source of fuel for cooking:
8. Summing up

CHAPTER 5: DETERMINANTS OF HOUSEHOLD COOKING FUEL USE IN SIKKIM.....Pg.No-96-112

1. Factors Affecting Fuel Choice
2. Regression Analysis
 - 2.1. Multinomial Regression (Supply Side)
 - 2.2. Multinomial Regression (supply + social side)
 - 2.3. Multinomial Regression (Socio-demographic and environment side)
3. Summing up

CHAPTER 6: INTERVENING FACTORS IN ACCESSING COOKING FUELS.....Pg.No. 113-131

1. Introduction
2. Fuel switching
3. Intervening factors in accessing household cooking fuels
4. Attributes based fuels preferences
5. Determinants in accessing LPG
6. Behavioral attributes in fuel use
7. Summing up

CHAPTER 7: GENDER AND HEALTH ASPECT IN FUEL USE.....Pg.No. 132-153

1. Introduction
2. Indian context
3. Sikkim and its policies towards women empowerment
4. Socio-economic characteristics and fuel use variation among gender
5. Media exposure and household cooking fuel use
6. Decision making and household cooking fuel use
7. Health assessment among children and women
8. Level of health and other insurance
9. Summing up

CHAPTER 8: POLICY SUGGESTIONS ON FUEL USE.....Pg. No.-154-187

1. International scenario
2. Indian scenario
3. Sikkim: Policies on energy sector
4. Primary source of fuel for cooking
5. A supply-demand nexus in rural Sikkim
6. Firewood
7. Joint Forest Management (JFM)
8. Liquefied petroleum gas (LPG): Provision of LPG distribution system in Sikkim
9. Kerosene and electricity
10. Environmental Awareness
11. Summing up

CHAPTER 9: CONCLUSION AND SUGGESTIONS.....Pg.No- 188-195

REFRERENCE:.....Pg. No-196-205

APPENDIX:Pg. No. 206-217

List of Tables

List of tables	Title	Page No.
	Revenue Block (Village), Forest Blocks, Statutory Towns and Census Town in Sikkim	37
Table 3.1		
Table 3.2	Population growth in Sikkim at each census from 1901 to 2011	38
Table 3.3	Basic information of Sikkim, Census of India, 2011	38
Table 3.4	Population and number of towns, 2011	41
Table 3.5	Size, Class and status of Towns	41
	Municipal Corporation, Municipal Council and Nagar Panchayat Wards in Sikkim	42
Table 3.6		
	Forest Products Collected by Respondents for Own Consumption (values in percentages)	46
Table 3.7		
	Percentage of households by availability of major fuel used for cooking in Sikkim, Census of India, 2011	47
Table 3.8		
	Types of fuel used for cooking in Sikkim: Firewood, 2001- 2011(in percent)	47
Table 3.9		
	Types of fuel used for cooking in Sikkim: LPG, 2001-2011(in percent)	47
Table 3.10		
	Percent distribution of urban, rural and total households by cooking fuel, Sikkim, 2015-16, NFHS-4	50
Table 3.11		
Table 3.12	Percentage of household using clean fuel for cooking, NFHS-4	51
Table 3.13	Use clean fuel for cooking (percentage) - DLHS-IV (2012-13)	51
	Percentage of household by fuel used for cooking in Sikkim, 2012-13	51
Table 3.14		
	Percentage of type of fuel used for cooking in Sikkim, NFHS-3 (2005-06)	51
Table 3.15		
Table 3.16	Selected villages from the North district, Sikkim	54
Table 3.17	Number of sampling household from each village	55
Table 3.18	Selected villages household from East district, Sikkim	55
Table 3.19	Number of sampling household from each village	55
Table 3.20	Selected villages household from West district, Sikkim	56
Table 3.21	Number of sampling household from each village	56

Table 3.22	Selected village from South district, Sikkim	57
Table 3.23	Number of sampling household from each village	57
Table 4.1	Population, density and urban population of Sikkim	59
Table 4.2	Descriptive Statistics of the study area	60
Table 4.3	Household cooking fuel in Sikkim (household in numbers)	69
Table 4.4	Socio-economic and demographic profile of study area (in percent)	71
Table 4.5	Basic household characteristic and fuel use	79
Table 4.6	Primary source of fuel for cooking across socio-economic-demographic and environment profile (in percent)	84
Table 5.1	Household cooking fuel use across geographical factors in study area (rural Sikkim)	103
Table 5.2	Multinomial Regression (Supply Side)	105
Table 5.3	Multinomial Regression (supply + social side)	108
Table 5.4	Multinomial Regression (Socio-demographic and environment side)	111
Table 6.1	Level of fuel switching from unclean/tradition to clean/modern	114
Table 6.2	Intervening factors in accessing firewood	115
Table 6.3	Intervening factors in accessing kerosene	116
Table 6.4	Intervening factors in accessing LPG	117
Table 6.5	Perception on firewood	119
Table 6.6	Perception on LPG	120
Table 6.7	Perception on Kerosene	121
Table 6.8	Logistic regression for using LPG by socio-economic characteristics.	123
Table 7.1	Cooking practices among household members (in percent)	136
Table 7.2	Firewood collection (in percent)	137
Table 7.3	Exposure to media (in percent)	139
Table 7.4	Availability of banking and health services in women (in percent)	139
Table 7.5	Household decision making process (in percent)	140
Table 7.6	Women autonomy (in percent)	142
Table 7.7	Media exposure and household cooking fuel use (in percent)	143
Table 7.8	Decision making and household cooking fuel use (in percent)	145
Table 7.9	Self reported health attribute problems among children in firewood user (in percent)	147
Table 7.10	Self reported health problems among women in firewood user (in percent)	147
Table 8.1	Some of the major initiatives to deal with climate change issues	154
Table 8.2	Sustainable Development Goals	155

Table 8.3	Facts and figures	156
Table 8.4	Percentage of household cooking fuel use in Sikkim	161
Table 8.5	Demand side (in percent)	161
Table 8.6	Supply side (in percent)	162
	Forest Products Collected by Respondents for Own	
Table 8.7	Consumption (in percent)	165
Table 8.8	Trends in forest cover at district-level (sq. km.)	165
Table 8.9	District wise forest cover (area in sq km)	165
Table 8.10	Number of Joint Forest Management Committee	166
Table 8.11	Purpose of fuel use and their source (in percent)	167
Table 8.12	Awareness about JFM and forest rules (in percent)	168
Table 8.13	Dependence on forest (in percent)	169
Table 8.14	Factors hindering the firewood use in rural Sikkim	172
Table 8.15	Firewood as compared to years ago	173
Table 8.16	LPG rates across Sikkim	174
Table 8.17	LPG use (in percent)	175
Table 8.18	Factors hindering the LPG use in rural Sikkim	177
Table 8.19	Best solution for LPG distribution: Peoples' prospective	177
Table 8.20	LPG as compared to years ago	178
Table 8.21	Factors hindering the Kerosene use in rural Sikkim	180
Table 8.22	Kerosene as compared to years ago	180
Table 8.23	Electricity use (in percent)	181
Table 8.24	Electricity as compared to years ago (in percent)	182
Table 8.25	The level of environment awareness in Sikkim (in percent)	184

List of Figures

		Page No.
Figure 1.1	Energy ladder	8
Figure 6.1	Conventional use of firewood (in percent)	128
Figure 6.2	Type of conventional use of firewood	129
Figure 6.3	Food taste variation (in percent)	130
Figure 7.1	Comparison of self reported health problems among children and mother (in percent)	148
Figure 7.2	Percentage of health insurance	150
Figure 7.3	Percentage of life insurance	151
Figure 7.4	Percentage of Other insurance	152

List of Maps

		Page No.
Map 3.1	Location map of study area (Sikkim)	36
Map 3.2	District wise distribution of fuel use in Rural area of Sikkim in 2001 and 2011	48
Map 3.3	District wise distribution of fuel use in Urban area of Sikkim in 2001 and 2011	49

Abbreviation

APL	Above Poverty Line
ARI	Acute respiratory infection
BPL	Below Poverty Line
CFA	Central Financial Assistance()
CNG	Compressed natural gas
COI	Certificate of Identification
COPD	Chronic obstructive pulmonary disease
CPRs	Common Property Resources
DBTL	Direct Benefit Transfer of LPG
DG	Discipline Guidelines
DLHS	District Level Household Survey
EDC	Eco development Committee
FSI	Forest Survey of India
GoI	Government of India
GoS	Government of Sikkim
JFMC	Joint Forest Management Committee
IAP	Indoor Air Pollution
IEA	International Energy Agency
IIPS	International Institute for Population Sciences
IPCC	Intergovernmental Panel on Climate Change
km	Kilo meter
LPG	Liquefied petroleum gas or liquid petroleum gas
NBMMP	National Biogas and Manure Management Programme
MDGs	Millennium Development Goals
MoU	Memorandum of understanding
NFHS	National Family Health Service
NGOs	Non-governmental organizations
NITI	National Institution for Transforming India
NPBD	National Project on Biogas Development
NSSO	National Sample Survey Office
OMCs	Oil Marketing Companies

PDS	Public Distribution System
PAHAL	Pratyaksha Hastaantarit Laabh
PM	Particulate matter
PMUY	Pradhan Mantri Ujjwala Yojana
RGGLVY	Rajiv Gandhi Gramin LPG Vitaran Yojana
SHG	Self Healp Groups
SC	Scheduled Caste
SDGs	Sustainable Development Goals
TB	Tuberculosis
ST	Scheduled Tribe
TV	Television
UN	United Nations
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1. Introduction:

'Life' is the unique feature of our planet earth. Earth has gone through various time periods. Evolution of human being is considered as the landmark development on planet earth. Human civilization with their intelligence has led so much development. However, such development is both boon and bane. Human being has reached a pinnacle where its own developmental activities have been posing threat to planet earth and its living creatures. Nature has altered considerably due to human induced activities. The issues like 'climate change', 'global warming' and 'environmental degradation' have been serious problem which do not recognize artificial boundaries/borders. In simple, the elasticity of human activities has been making our environment/earth inhabitable. It is the fact that, the aspect of climate change was prevalent in previous period as well induced by natural phenomena but the nature/degree/intensity was different from the present which is mostly human induced. Now, the world has becoming more and more prone to various harsh climatic conditions. The intensity and vulnerability of such climatic conditions have increased over the years with the increasing pace of economic growth and development activities. Overexploitations of natural resources have been triggering the problems like degradation of land, pollution which enhances the risk factor to many disasters. The concepts like 'climate change', 'global warming' and 'environmental degradation' have been the topic of discussion across the world. The problem of climate change has been the most challenging in front of humankind (Adger. W.Neil, Loronzini. I and O'Brien L. Karen 2010).

At present, all the countries of the world are in various development stages. The form of government and market structures varies across the countries ranging from capitalist to socialist and mixed. The development process and market structure along with the advancement in science and technology or scientific 'know how' influences the industrialization process. The economic growth and industrialization are two most important aspects which are deeply imbedded in the concept of development; and have significant role

in categorizing the countries. On this basis, countries are categorized into 'developed', 'developing' and 'under developing'. In narrow sense, 'development' and 'industrialization' synonymously uses to level countries into various stages. The process and growth of industrialization intensify the formation and creation of capital good. In the process, countries overexploit the resources which lead to environmental issues/degradation if it is done in unsustainable way.

Globally, the environmental challenges like 'climate change' and 'global warming' are major concern. All the countries are bound to deal these issues in every possible way so that its effect is minimal. However, within the issues of countering the environment crisis there is differences of opinion. For instance, developed countries have been consistently trying to impose equal responsibility to developing countries to deal these challenges irrespective of development stages. On the other hand, developing countries have been resisting this arbitrary notion by arguing that they are still in nascent stage of development. Unlike developed countries and their economy (industrialization), under developed and developing countries still need to depend on resource extraction so that they achieve narrow sense of 'development'. The disagreement between these countries needs to reach its deadlock as soon as possible to counter the 'common' global issues without any further delay. Therefore, the development and environment dynamics need to study with more systematic, scientific research, effective rules/regulations and equity in their implementation process at global, regional, national and local level.

2. Global agreements to curb climate change:

Lately, the issues of climate change and global warming are getting attention. By realizing the adverse effect of climate change, leaders of the world have started initiatives to counter these issues. In the past, some efforts were made directly or indirectly to highlight the importance of these issues. In this context, a major watershed development took place in history (in 1992) when leaders of the world gather to discuss the issue of climate change and global warming at Kyoto (Japan) aiming to curb the green house gas emission. Unfortunately, the Kyoto summit agreement was hardly followed by the countries of the world. Later in "Rio de Janeiro (Brazil)" 1992 leaders from across the world met to discuss climate related issues which came to known as "Earth summit". The "Kyoto Protocol" came

into force in 2005. In 2000, the United Nations adopted eight “Millennium Development Goals (MDGs)” and agreed that all 191 UN member states have agreed to achieve it by the year 2015. Again in 2012, countries were gathered in “Rio de Janeiro (Brazil)” for the “United Nations Conference on Sustainable Development” which is known as “Rio+20” or “Rio Earth Summit” organized by United Nations (UN). In 2015, UN adopted “Sustainable Development Goals (SDGs)” by replacing MDGs. The SDGs have 17 goals, covers wide range of development aspects which is set to achieve its target in the year 2030. Among these, the goal number 7 deals with “ensure access to affordable, reliable, sustainable and modern energy for all” on which this research/thesis is based and particularly tries to explore the level of household cooking fuel and its relevance in rural areas Sikkim – an Eastern Himalayan state.

The Eastern Himalayan area has fragile geology which is sensitive to climate change and global warming which needs urgent attention. The unscientific and negligence management of mountain environment is bound to have impact on climate which is the rich source of ecosystem services. Considering these aspects, Sikkim- where majority of people lives in rural areas and most of them are dependent on firewood for household cooking fuel is bound to have environmental and socio-economic implications. Therefore, it is imperative to explore the interconnect system of livelihood, demand and supply aspect which have been hindering rural people in accessing clean fuel incorporating socio-economic, environmental or physical aspects.

3. Sustainable Development Goal (7): “Ensure access to affordable, reliable, sustainable and modern energy for all”

The “sustainable development goals” are comprehensive set of targets for overall welfare of planet earth and its components incorporate the present and the future generation; and aimed to achieve in 2030. Among 17 “sustainable development goals”, the goal number 7 i.e “ensure access to affordable, reliable, sustainable and modern energy for all” concern area of this research/thesis. Access to energy is essential and central to every major challenge of world be it like food security, climate change. Energy accounts 60% of total global greenhouse gas emission making it as the major driver to climate change. As per United Nations (UN) report, one in five people lacks access to modern electricity and 3 billion

people depend on traditional cooking fuels like wood, coal, charcoal or animal waste for cooking and heating purposes.

Under this goal, there are many targets to achieve for overall energy access to all viz., modern energy services, renewable energy, energy efficiency, quality infrastructure and upgrade technology for supplying modern and sustainable energy services with the primary aim to reduce the carbon intensity of energy in long term climate goals¹.

4. Energy at glance:

Energy is very essential to sustain life. The term ‘energy’ is board concept which is difficult to define in single definition because of its various contextual implications. ‘Energy’ in a larger context is ‘resource’. The terms sometimes use interchangeably with each other. ‘Energy’ is basic need of life or it is basic human needs for survival. Discovery of ‘fire’ by early people is the breakthrough development in human progress/civilization. The fuel for cooking food is the basic energy requirement for survival. In this context, firewood can be called as the first source of fuel use by human being. It is the primary source of fuel which is still the main source of fuel for some section of people. The firewood is sometimes referred as “energy of the poor” (Horst and Hovorka 2008). It is considered that environmental resources act like complementary in production and consumption function for poor and rural population. For example, water is required in agriculture production, likewise, firewood in relation to consumption of food (National Environment Policy 2006). The household cooking fuel is an important development component and use of various fuels has multiple socio-economic implications. The household cooking fuel is broadly categories into clean or modern fuel and solid fuels.

Clean fuel: Clean fuels are those which do not leave much residues and smokes which do not pose much environmental public health concerns. For example, Liquefied petroleum gas or liquid petroleum gas (LPG) and Compressed natural gas (CNG) are classified as clean fuels.

Solid fuels: Charcoal, firewood and kerosene is referred as solid fuels or unsafe fuel. These are rudimentary and unsafe form of cooking fuel which have environmental and public health

¹ <http://www.un.org/sustainabledevelopment/energy/>

concern. The emission from such fuels releases black carbon which is main components of global warming and global warming.

5. Access to modern and clean fuel:

Household cooking fuel is closely related with human development (Modi et al. 2005). It has various socio-environment implications. It is very important to have access to clean energy. Access of various cooking fuels has been a major problem due to increasing population pressure, scarcity of alternative source and their environmental and climatic significance. Access to electricity and clean cooking technologies/ appliances is an important development goal which is closely related with other development goals (World Bank 2003). The term “access to energy” is very difficult to define because energy has multiple uses. Energy not only used as household purposes but it also has commercial or industrial purposes in various places like hospitals, schools etc. “Access is defined as the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive enterprises, and community institutions” (Energy Sector Management Assistance Program 2014).

The firewood use as cooking fuel is a big concern because of various implications associated with firewood use; deforestation is one direct impact. Most of the research works states that, the use of firewood accelerates the deforestation process. There was a debated in mid 1970s, that the increasing population dependency on firewood for cooking energy will lead to over exploitation of forest especially in the lives of poor and rural livelihood. However, in 1980s counter argument by some of the researcher stated that the issue of deforestation is not as critical as estimated. It is overestimated as the use of firewood as cooking energy will not lead any considerable impact on forest resources, so it is not required to intervene just for use firewood use. Therefore, in later years, most of the conservatory forest policies were terminated. In firewood use also ‘income’ is one of determining factor. In economic term, it is considered that income as ‘normal’ goods for lower income households and ‘inferior’ goods for higher income households. But in actual, it’s real cost of firewood even for poor is very high; therefore effective policies should be to counter this issue by switching to clean

cooking energy. The charcoal is considered as the “transition” (Arnold, Kohlin and Persson 2006).

Firewood is the primary source of cooking energy of many poor people especially in developing countries like India (Arnold, Kohlin and Persson, 2006). The concern associated with firewood use is “Indoor Air Pollution (IAR)” and its negative health impact especially to children and women. It is estimated by the “World Health Organization (WHO)” that 2.5 million women and young children die prematurely from breathing the fumes from indoor biomass stoves (IEA 2002; World Bank 2003). Now a day, there are several cooking fuels which basically vary in their energy output, intensity, cleanness, residual output and their implications on health and environment.

But, firewood is still the primarily source of fuel especially in rural areas. People from Africa, Asia and south-Asian countries where there are considerable number of people who are still dependent on firewood for cooking purposes. There is wide disparity exists between rich – poor, rural-urban in terms of accessing clean/modern cooking fuels. Dependent on solid fuels like firewood, charcoal, kerosene have grave environment and public health concerns especially of women and children. In developing countries, especially in rural areas gender based work is rampant and society is based on patriarchy. In such gendered based society, work is also divided between women and men where they are assigned to respective work which can be clearly seen even in their household division of works. Likewise, there is division in household cooking management where women by default assigned in drudgery firewood collection and cooking food for family members and men are engaged in other household activities. Assignment of women in cooking based on solid fuels has multiple implications embedded in factors which have direct so socio-economic, environmental and public implications. Women who are engaged in such drudgery cooking practices based on solid fuels have their health in danger because of the danger of smoke coming out from such fuels. Smoke which emits from such solid fuels contains poisonous gases like carbon monoxide, carbon dioxide or carbon shoot which is harmful for health. Research shows that long term exposure to smoke leads to the dangerous disease like asthma, cancer, Tuberculosis (TB), blindness among others. Further, not only women but their children are also at risk of smoke because children usually stay with their mother; so it is obvious that

children are also exposed to dangerous smoke. In nut shell, women/ children and their health are at risk due to drudgery household cooking process which also has socio-environmental implications. Therefore, it is imperative to find alternative solution to release such drudgery burden of household cooking based on solid fuels from women in society. Efforts should be made to provide alternative modern or clean fuels for household cooking to scale up aged old practice of cooking. However, to provide clean or modern household cooking fuels, efforts should be made from all stakeholders like governments, institutions, companies, communities, “Non-governmental organizations (NGOs)”, individuals at global, national, regional and local level. Previously made efforts like provision of maximization of clean cooking fuels use could not result satisfactory outcome. Now, an intervention should be made so that every household gets access to clean cooking fuels. In other words, efforts should be made to switch fuel from traditional/solid fuel to clean fuel use, this process sometimes called fuel switching/transition.

The process of fuel transition or fuel switching is sometimes equated as a “development path” and household using various fuel are level in different “development level” where firewood constitute the lower levels (Smith 1987). In rural areas, the process of fuel switching is very poorly understood (Leach 1992). Access to electricity, LPG/CNGs, and use of biogas to household are considered access to clean fuel (energy). On the other hand, use of biomass fuels like firewood, vegetable wastes and cooking on traditional ‘*chulhas*’² are termed ‘unsafe fuel’.

6. Two major models on household cooking fuel:

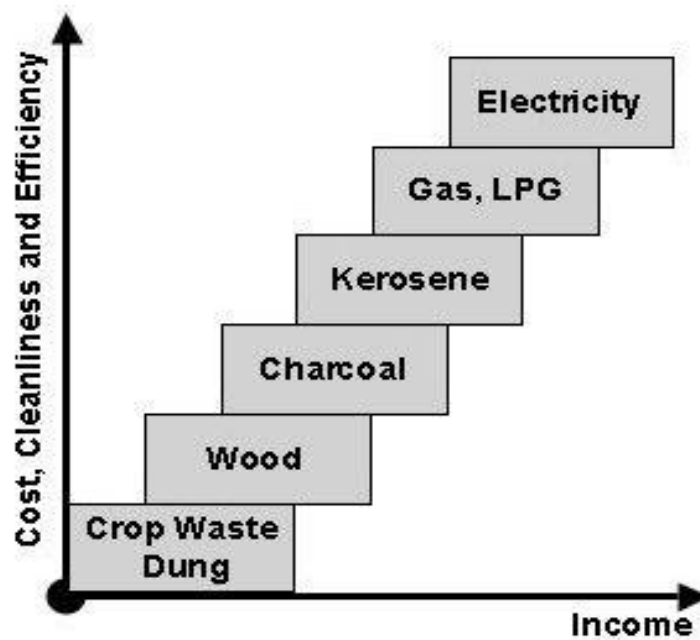
6.1. Energy ladder model:

It states that there is an improvement in the clean energy consumption with the increase in the household income. In other words, as income increases, the energy types used by households would be cleaner and more efficient, but more expensive as moving from traditional biomasses to electricity. Or, as income increases the accessibility to clean energy

² a small earthen or brick stove

also rises. It implies that moves are made from inferior to superior fuels. Besides income, the urbanization is considered as important in “energy ladder model”.

Figure 1.1: Energy ladder



Source: Janssen and Rutz, 2012.

6.2. Multiple energy model:

The concept of multiple fuel models states that “different energy ladders for different types of applications” (Foster et al. 2000). The multiple fuel strategy helps households maximize fuel security and at the same time receive the advantages of different fuels (Masera, Saatkamp and Kammen 2000).

CHAPTER 2

LITERATURE REVIEW

1. Global scenario:

Growing evidence shows various disadvantages accompanied with traditional biomass fuel use. There are various studies that have conducted to examine the factors responsible for fuel choice. However, very limited implementation work has done to improve the situation or the success rate is low. The available literatures are mostly concentrated on the issues of exposure to Indoor Air Pollution (IAP) emitted from traditional stove using biomass fuel and resulting health effect. Ezzati and Kammen (2002) cited in their work that such type of research began in the 1960s and 1970s in India, Nigeria, and Papua New Guinea. Though, it is widely known and highlighted in various study that IAP resulting from cooking smoke is the major factor contributed to various respiratory diseases, a systematic and comprehensive analyses of determinants of the uses of various fuels and their solution in a bigger context is still limited.

In recent times, access to energy has got greater attention particularly from the year 2012 when United Nations declared “Sustainable Energy for All” (Bhatia and Angelou 2014). The launch of sustainable development goals in 2015 by replacing the “Millennium Development Goals (MDGs)” further give impetus where goal 7 exclusively deals with “access to affordable, reliable, sustainable and modern energy for all” (SDG 2015). However, to make this successful, collective intervention is needed from the global to local level. The success of intervention is depend on understanding the accessibility aspect of energy followed by well formulated planning, monitoring process (Bhatia and Angelou 2014).

According to the Energy Poverty Action initiative of the “World Economic Forum”, “access to energy is fundamental to improving quality of life and is a key imperative for economic development”³. Likewise the “International Energy Agency (IEA)” states that, “use of traditional biomass will decrease in many countries, but is likely to increase in South Asia

^{3,4} https://en.wikipedia.org/wiki/Energy_poverty

and sub-Saharan Africa alongside population growth”⁴. It is estimated that around 52% of the world population use solid fuels like wood, dung, coal etc as their primary fuel (Rehfuess et al.). The WHO (2014) recommends a complete transition to the use of gaseous fuels or electricity based cooking to eliminate health impacts from pollution arising from cooking. A report “Investing in Development: A Practical Plan to Achieve the Millennium Development Goals” also recommended to adopt to reduce the number of people without effective access to modern cooking fuels by 50% and make improved cook stoves widely available by 2015 (United Nations 2005).

2. Indian scenario:

The impact of climate change in India would be greater considering its population size, dynamic climatic condition with its diverse physiographic. India is a second largest population and most of the population is dependent on agriculture for their sustenance. India’s population contributes 17% in world - second only to China. But, India is not fortunate to have the potential of resources like coal, oil and gas. India has only 0.4%, 0.4% and 6% of the world’s oil, gas and coal reserves respectively which is very low in proportion to the total population (NITI Aayog 2015). Therefore, India has greater challenges in planning, monitoring and implementing the development process in a sustainable way. Energy sector in India needs a critical evaluation which addresses multiple challenges like social, environmental challenges and simultaneously sustaining demanding economic growth (Khosla, Dukkipati, Dubash, Sreenivas, Cohen 2015). India’s energy security is primarily concern with continuous supply of energy at all level with competitive price to sustain economic growth and support household needs of clean, safe energy and affordable energy of all form (Annual report, Government of India 2014-15).

In India, 31.4% of households use kerosene lighting and 65.9% of households use bio-fuels for cooking (Census of India 2011). As per 2011 census, over 86% of rural Indian households used solid fuels for cooking. Most of the rural populations of India are depended on traditional cook stoves or ‘*chulhas*’ for cooking purposes (Jain, Choudhary and Ganesan 2015). As per NITI Aayog (2018), 43.8% households in India use clean cooking fuels but rural households constitute only 24% while urban households constitute 81%. As per 68th

NSSO data, suggests that as of 2011-12, around 80% of the Indian households used some form of traditional fuels to satisfy their cooking and heating needs (Jain et al. 2014). India's energy accounts 77% of greenhouse gas emissions. (Dubash, Khosla, Rao and Sharma 2014) It is estimated from the NSS data suggests that only 50% of India's cooking energy is derived from LPG which is considered as clean fuel (energy) (Jain et al. 2014). Electricity-based cooking is best solution in the 'clean' aspect because of zero point of use emissions (Jain, Choudhary and Ganesan 2015).

The LPG marketing started in the year 1995 at Bombay. Over the years, LPG market has considerably extended most part of the country and has significant number of LPG user which is further projected to grow due to its plan to coverage in rural areas. Distributers of LPG are appointment by "Public Sector Oil Marketing Companies (OMCs)" and they are bound by OMCs agreement; in addition, they are also bound by "Marketing Discipline Guidelines (MDG)" as well for smooth functioning. In 1982, the 1st MDG for LPG distributorships was introduced and later revised thrice in 1988, 1994 and 2001. In 1960s, LPG was introduced as a domestic fuel (Energizing Growth of the Nation, Ministry of Petroleum and Natural Gas, the Government of India 2014-15).

India has initiated to provide LPG over three decades ago to all the population for shifting traditional unclean fuel use to clean cooking fuel. Unfortunately, till now its coverage is limited to only 20% of total population (Jain, Agrawal, and Ganesan 2014). The alternative source of would be the use of kerosene but its usages are very low, accounts only 0.7% of rural household uses kerosene as their primary cooking fuel (Census of India, 2011). It also has health effect like burning of other unclean cooking fuel. Therefore, it is better to promote LPG over kerosene. In India, accessibility of clean cooking fuel (energy) has many implications. The provision of clean cooking energy like LPG can considerably reduce the indoor air pollution which has adverse health effects (Jain, Choudhary and Ganesan 2015). In this aspect, biogas is one of the alternatives to provide clean cooking fuel (energy) but its practical use has some difficulties like high cost of production/maintenance and low fuel intensity.

3. Changing national policies on household cooking fuel:

In 1981, India had launched the “National Project on Biogas Development (NPBD)” with the aim of providing clean cooking energy especially to rural population. Unfortunately, it could not succeed because of problems like poor performance, failure and high non-functionality rates. Later, it renamed and restructure with some modification into the “National Biogas and Manure Management Programme (NBMMP)” with objective of going beyond the provision of clean cooking energy (Jain,Choudhary and Ganesan 2015).

At least, thereafter, India became aware and concern about the adverse effect of such emissions. For instance, India’s 12 Five Year Plan and “National Action Plan on Climate Change” initiated the sustainable development giving emphasis on multidimensional approach to address the climate change issues. It is very essential to have the effective measure to curb the harmful emissions as the future use of fossil fuels is going to increase (Dubash, Khosla, Rao and Sharma, 2014). The “Vision-2015” adopted for LPG sector inter-alia focuses on raising the population coverage of LPG with the focus on rural areas and areas where LPG coverage is low. The Vision-2015 envisages to achieve 75% population coverage in the country by releasing 5.5 crore new LPG connections by 2015 especially in rural areas and under-cover areas. To achieve this objective a new scheme called “Rajiv Gandhi Gramin LPG Vitaran Yojana (RGGLVY)” was launched in 2009 for setting up small size LPG distribution agencies. Under this scheme financial assistance at a time is granted to the “Below Poverty Line (BPL)” for new LPG connection through RGGLVY (Energizing Growth of the Nation, Ministry of Petroleum and Natural Gas, the Government of India 2014-15).

In recent years, the Government of India has been formulating various programmes to provide clean fuel to all by promoting schemes like city gas distribution networks for PNG, the “Unnat Chullha Abhiyan” for improved cook stoves, the NBMMP for biogas plants and RGGLVY and LPG subsidy to reach the grass root level (Jain, Choudhary and Ganesan 2015). The Government of India has formulated a policy where each household are eligible to get six LPG cylinders per year. It is the indirect way of bringing down the burden of government in providing energy in a manageable level (Patra 2012). Likewise, government of India has also initiated “PAHAL DBTL (Direct Benefit Transfer of LPG)” scheme on June

1, 2013. Its objective is to give cash subsidies on cooking gas and it covered 291 districts of India. After examining the scheme, the scheme modified and re-launch in 54 districts on November 15, 2014 to cover 2.5 crore households. Later on January 1, 2015 it again revised and started to cover all the districts of the country. In previous scheme, the Aadhar card was mandatory for all consumers to receive the LPG subsidy. The compulsion of Aadhar card posed a big problem for consumers who did not have the Aadhar card, which meant that they could not avail the subsidy. However, under the modified scheme LPG subsidy made available to all consumers, now they are entitled to receive subsidy in their bank account under two options: with Aadhar and without Aadhar⁵. The direct transfer of subsidy of LPG is expected to reduce the diversion of subsidized LPG cylinders for household cooking to the commercial and industrial sectors. Further, provision of 5 kg cylinder on 'cash and carry' basis is expected to reach clean and affordable cooking fuel at grass root level (Annual report, 2014-15). The policy was also formulated on the basis of income- if the customer has annual income of 10 lakh and above he or she cannot eligible to receive subsidized LPG cylinder. The Government declared that they will charge the full unsubsidized price of cooking gas tap to all customers who earns more than Rs 10 lakh annually (The Hindu 2016). Recently, the cabinet approves "Pradhan Mantri Ujjwala Yojana" - Scheme for Providing Free LPG connections to women from BPL Households. Under the scheme, Rs 8000 crore has been earmarked for providing five crore LPG connections to BPL households. The scheme provides a financial support of Rs 1600 for each LPG connection to the BPL households. The identification of eligible BPL families will be made in consultation with the State Governments and the Union Territories. This scheme implementation plan period is over three years viz., the Financial Year 2016-17, 2017-18 and 2018-19 (The Ministry of Petroleum and Natural Gas, Govt. of India).

4. Biomass as cooking fuel and its implications:

A substantial amount of fuel used in households of developing countries is biomass fuels such as firewood, crop residue, and dung. Cooking being a basic need, it uses large share of the total energy required in developing households (Natarajan 1985 as cited in Farsi, Philippine, & Pachauri 2007). In 2011, it is estimated that about 2.6 billion people are

⁵ <http://www.mapsofindia.com/my-india/society/what-is-pahal-and-how-is-it-going-to-benefit-lpg-users>

dependent on solid fuels for cooking in developing countries. Among them more than 50% are living in India, China, and Bangladesh. In the absence of any intervention, due to population growth in these biomass fuel dependent regions, it is projected that still 2.6 billion people will rely on biomass fuel by the year 2030 (International Energy Agency 2012, 2013). Moreover, majority of the households are using the fuel in traditional inefficient stoves without chimney or in a poorly ventilated condition (Legros, Havet, Bruce, & Bonjour 2009). Burning biomass fuels in inefficient traditional stoves and open fire discharge ample of smoke due to incomplete combustion. The smoke which contains mainly particulate matter, carbon monoxide, nitrogen dioxide, formaldehyde and various polycyclic organic matters are the major contributors of IAP (Rehfuess, Bruce & Smith 2011). It is found that level of IAP in developing countries households using biomass fuel are very much above the WHO air quality guidelines (Bruce, Rehfuess, & Smith 2011). For instance, in biomass using households, a typical 24 hour concentration of PM₁₀ (Particulate Matter of size 10µg) ranges from 200 to 5000 µg/m³ while the standard concentration for daily average given is less than 150µg/m³(Ezzati & Kammen 2002; Desai, Mehta, & Smith 2004). Several studies put forward various adverse effect of using biomass fuel that ranges from environmental problem such as global warming, deforestation and soil erosion to loss of human productivity and gender equity as a result of collection and processing of the fuel and finally to serious health threat specially in women and children (Lewis & Pattanayak 2012; Mekonnen & Kohlin 2009; Pandey & Chaubal 2011; Rehfuess et al 2011).

It is well documented that exposure to IAP results from biomass fuel used as a causal agent for a range of diseases such as acute respiratory infection (ARI), chronic obstructive pulmonary disease (COPD), asthma, TB, cancer of nasopharynx and larynx, perinatal condition, low birth weight and cataract (Boy, Bruce, & Delgado 2002; Bruce, Perez-Padilla, & Albalak 2000; Ezzati and Kammen 2001, 2002; Mishra, 2003a, 2003b; Mishra, Dai, & Smith 2002, 2004; Mishra, Retherford, & Smith, 1999a, 1999b, 2005a, 2005b; Parikh, Biswas, & Karmakar 2003; Siddiqui et al 2008; Smith, Samet, Romieu, & Bruce 2000). It is estimated that (Lopez, Mathers, Ezzati, Jamison & Murray 2006a) 3.2% of the total death and 2.7% of the global burden of diseases in 2001 is because of indoor smoke from household used of biomass fuel.

Reviewing all these ill effects, United Nations Millennium project has advised the countries to take up individual cooking energy target to halving the population that depend on traditional biomass fuel for cooking and make improved cooking stoves extensively available by the year 2015 (Rehfuess et al 2011). One important aspect of it is enhancing the target of reducing infant and child mortality of the MDGs by reducing mortality attributes to smoke from biomass fuel (Legros et al 2009). Reducing population incline to biomass fuel or increasing access to clean fuel (electricity, LPG, biogas, kerosene etc.) would have multifaceted benefit in the society, though, the various efforts of international agencies, organization, and national governments turns futile since little is gain so far.

Over the years several studies are conducted all over the world to establish the factors that catalyst the use of biomass fuel in developing countries. Among various factors, income, opportunity cost of the people, place of residence and level of education are widely acclaimed determinants of the use of biomass fuel (Farsi et al 2007; Heltberg 2004, 2005; Joon, Chandra & Bhattacharya 2009). The extended review of literature is incorporate and can be examine in the next chapter.

According to “International Institute for Population Sciences (IIPS-2007)”, in India, 71% of the total households are using solid fuel as cooking fuel in 2005-06. Proportion relying on solid fuel for cooking across the states of India depicts large variations which range from 9 percent in Delhi to around 90% in Bihar, Jharkhand, and Orissa. Northeast part of India is one of the regions that heavily rely on solid fuel for cooking. Though, proportion of households depends on solid fuel in Mizoram is only 34%, remaining seven states of the region highly depends their daily energy for cooking on solid fuels. In fact four states of the region viz., Assam (76%), Meghalaya (72%), Nagaland (76%), and Tripura (80%) are well above the national level.

It is known fact that the dependence on wood as a fuel can put pressure on forest which results adverse environmental impact at both local and global level. It is assume that increasing rural population along with the increasing demand of firewood has been one of the major causes of deforestation in developing countries (Norman 1984). Firewood has been a key source of energy for households especially in developing countries, leading to deforestation. Besides environmental impacts, the use of firewood for fuel has very large,

negative impacts on health (Edwards and Langpap 2005). Exposure to indoor air pollution leads to adverse health condition especially to women and children (Smith et al. 2014). In addition, a substantial amount on money and time (collection) has to spend in access to fuels especially of poor people particularly women and children.

Use of solid fuels as cooking and heating on traditional cook stoves with poor ventilator facilities leads indoor pollution which in turn has adverse health impact. The most of the solid fuel users are poor and live in rural areas and their ability to afford health facilities are limited (Rehfuess, Mehta and Pruss-Ustun 2006). Burning of solid fuels like wood has various health and environmental implications. It has negative health impact especially to children and women because cooking room fills with pollutants like particulate matter, carbon monoxide which have the tendency to penetrate into the lung (Fields 2006). The use of traditional cook stoves results low thermal efficiency and also emit comparatively large amount of emissions which has adverse health and environmental implications. It is very important to recognize household energy consumption like solid fuels in the development programmes as a preventive measure to improve child and maternal health. The use of traditional cook stoves and its possible adverse health impacts is one of the major factors for policymakers to promote clean cooking energy options (Jain, Choudhary and Ganesan 2015). ‘Replacing outdated cook stoves and open fires with modern energy services would prevent 800,000 child deaths annually.’⁶

Burning of solid fuels like wood, charcoal, coal, animal dung and crop residuals as household cooking fuel which causes IAP has great environmental and public health challenges especially in developing countries (Ezeh K.O, Agho K.E, Dibley M.J and Hall J.J 2014). The use firewood has negative impact consequences like indoor air pollution, deforestation, labor intensive firewood collection process (Smeets, Francis, Johnson and Ballard-Tremeer 2012). It is the fact that, poor people have to suffer in large scale in financing to access the household cooking energy and it also often require considerable time in firewood collection especially of women and children (World Bank 2003).

⁶ Sustainable Energy for All 2012

In 1991, the Environmental Kuznets Curve also observed linkage of income and environmental quality in the process of economic growth. Kuznets argued that as per capita income increases, income inequality also increases at first but then, after some turning point, starts declining (Bruce, Vijayaraghavan, and Bhattara 2002).

As per IPCC report 2007, biomass supports 10% of the total global energy where wood, agriculture residuals and urban waste constitute around 70 – 80% (IPCC 2007). In firewood collection process, women and children tend to spend considerable amount of time than male counterpart (World Bank 2008). Use of firewood not only a public health concern but it also has environmental implications. It will directly contribute to deforestation and environmental degradation which is a great concern at this age where the concern of concepts like “climate change”, “global warming” are household name to everyone. The use of firewood is prevalent worldwide, but the intensity and frequency of its use is high in poor countries especially in rural areas.

The quality of air inside homes, offices, schools and other buildings where people spend a large part of their time is determinant of healthy life and people's well-being (WHO 2010). The indoor air pollution is one of the important human health risk factor, especially in poor and developing countries. Indoor air pollution is embedded in various socio-economic factors which are determined by the social-cultural practices like level of education, income or assets (Brown, Dassonville, Derbez, Ramalho 2015). The quality of fuel used in developing countries is low as compared to developed countries (Baldwin and Wood 1985). In turn, the use of low efficiency fuel leads to the many environmental as well as health effects. Individual health affect by number of factors viz., physical, social, economical. Indoor air pollution due to burning biomass fuels is one of the major factors which directly affect the individual's health by burning biomass fuels (WHO 2007). Biomass fuel is raw fuel with low efficiency in terms of combustion and cleanliness. It is responsible for the production of various pollutants like carbon monoxide, nitrogen oxides, formaldehyde, hydrocarbons and many others toxic products which pose a great threat to health (Smith, Aggarwal, Dave 1983). It is sometimes perceived that air pollution an urban problem linked with the industrialization and vehicular movement. However, importance of indoor air pollution is unrecognized some times as both health and environment challenges. The intensity of indoor

air pollution is particularly high in developing and under developed countries where major portion of population still dependent on firewood, crop residues, grasses, animal dung etc for household fuel. Use of these fuels means use of low combustion which emits harmful emissions like respirable suspended particulates, carbon monoxide, nitrogen oxides, formaldehyde, polyaromatic hydrocarbons etc. and exposure to this causes effect on health (Mishra, Retherford and Smith 2014) It in turn, results the phenomenon of indoor air pollution which has adverse effect on health especially to women and their children. Adverse effect of indoor air pollution is particularly high among women and children because most of women tend to engage themselves in household activities, especially in cooking activities. Therefore, they tend to be more vulnerable to the effect of indoor air pollution along with their children as compared to men.

In recent years, it is found that burning of biomass has great implication on climate change as it releases black carbon (soot). It is the residual part of biomass fuel results from the incomplete combustion process (Ramanathan and Carmichael 2008). Black carbon is the major contributor to climate change and traditional household cooking energy use is the significant source of black carbon (Bond et al 2004).

5. Factors affecting of household cooking fuel:

Energy transition or fuel switching become one of the priority areas for most of the developing countries as it would benefit the overall society in terms of health, environment and poverty reduction. Energy transition generally means shifting of households from using fuels in lower rung of energy ladder to higher rung of the energy. In other words, households' preference ranges from inefficient fuels such as dung, crop residue, firewood through more efficient fossil fuels to the most modern form of energy (Holdren and Smith 2000; Leach 1992). According to the energy ladder theory in its simplest fundamental idea, income is the sole factor for fuel switching. Further, households use higher rung of energy with the expense of lower rung of energy ladder completely. However, several factors which affect household's fuels choice and patterns of use are put forward by various studies.

Evidence from various studies shows lack of support of complete transition that using multiple fuels i.e. using biomass and clean fuel by the households is a common phenomenon

(Bruce et al 2011; Duflo et al 2008; Farsi et al 2007; Heltberg 2005; Joon et al 2009; Masera Saatkamp & Kammen 2000). The firewood is an important source of fuel in low income households. However household tend to switch to clean fuel if there is rise in household income (Gupta and Ravindranath 1997). As a critique to energy ladder model, Masera et al (2000) case study in Mexico village during 1992-96 confirmed that energy transition is not a simple linear progression from traditional to modern fuels as income increases. In other words, households do not switch completely from one fuel to another; but they use modern fuel without disposing of traditional fuels. The reason for this multiple fuel use is due to households' maximization of fuel security, technical and cultural preference. For example, a study conducted in a rural area of Haryana state of India (Joon et al 2009) found that households prefer traditional biomass fuel and stove while making bread (Chapatti) because they believe cooking with it is crispier and tasty. Thus, it is said that various fuel use is a product of complex interactions among socio-economic factors. Similarly, Heltberg (2005) examine the factors determining fuel choice in Guatemalan households experienced multiple fuels used by 48% (urban households) and 27% (rural households). The study found that opportunity cost related to biomass fuel apart from income level is an important determinant of fuel choice. For instance, in addition to locally available biomass fuel, low opportunity cost of labor and time for biomass collection in rural Guatemala leads to obstruct uptake of modern fuel as incidence of biomass use remains high in rural areas. The study also explains other factors which influence fuel choice such as education, electrification, and price of fuels. It is found that electrified households have a higher incidence using modern fuel compared to non-electrified households (Duflo et al 2008; Heltberg 2004, 2005). Further, Heltberg (2004) study in eight developing countries found that the probability of using LPG by electrified households increases by 28% in rural Brazil and 34% in urban India. Moreover, energy ladder theory is very problematic in rural settings than urban settings where household choice in rural areas is also determine by local availability without monetary expenditure or low marginal cost such as dung, crop residue, woods, and twigs (Bruce et al 2011; Farsi et al 2007; Heltberg 2005; Masera 2000). It is even more pronounced when considering high transaction cost, poor access and unreliable supply of modern fuel in rural areas.

The demographic dynamics are important drivers of environmental change and it has major role to play in climate change (Jiang and O'Neil 2009). Actually, household is the basic unit

of energy consumption as the demand for energy has been increasing continuous to match with the waves of economic and globalised world. Changes to population size, age structure, and urbanization as well as changes in household living arrangements are some the important demographic dynamics which have crucial role to play in development and environment interplay. A study conducted in rural India (Pandey & Chaubal 2011) using 61st Round of “National Sample Survey” observed an apparent association of various socio-economic factors with the uptake of clean cooking fuels. Among others, regular salary income, and monthly per capita consumption expenditure have a significant effect on uptake of clean cooking fuel whereas households having below poverty line card, family size, size of farm land, and belonging to reserved social groups have a significant negative association.

In India, it is estimated that environmental factors accounts 20% of burden of diseases which are mainly linked with dimensions of poverty e.g. malnutrition, lack of access to clean energy and water (National Environment Policy 2006). The economic condition of household is another important factor in affording the clean cooking fuel. It is very difficult to afford ‘clean cooking fuel’ especially to poor and rural population. As household gain socioeconomic status, they switch to the modern and clean fuel consumption abandoning polluting fuels like cow dung, wood, charcoal and also insufficient cooking appliances (Smith 1987; Barnes & Floor 1996). Household income is single most strong determinants of fuel choice (Gupta and Kohlin 2006). In household survey, it is found that income as a major determinant of the energy transition (Link, Axinn and Ghimire 2012). Accessibility of clean fuel like LPG is also determined by the regulated pricing and black markets and also affected by uncertain availability and supply side shocks (Gupta and Kohlin 2006). Fuel choice and adaptation of new energy technologies are also influenced by the individual characteristics, culture and tradition practices of region (Treiber, Grimsby and Aune 2015).

The cost of purchasing energy is one of the most important interactions between energy and welfare. As per “energy ladder model”, income group and urbanization are two important factors for fuel choice. It also state that clean fuel use is positively correlated with household electrification; inversely with those with household electricity. Likewise, expenditure, urbanization, level of education is major force in relation with clean fuel switching. It is also observed the tendency of various fuel uses i.e. clean and unclean among larger household

(World Bank 2003). Fuel and stove are observed as the major characteristics in fuel use which results multiple fuel use unlike traditional energy transition theory “energy ladder”. Energy economization is an important reason for energy diversification (Treiber, Grimsby and Aune 2015). In diverse countries like India, the multiple fuel model has its relevance than typical energy ladder model (Pachauri and Spreng 2003).

It is also seen that urbanization process as the alternative way of providing clean energy by resolving the issue of firewood crisis. The firewood is sometimes considered as “energy of the poor” (Horst and Hovorka 2008). A cross country analysis revealed that, there is positive relationship between economic growth and modern fuel consumption suggesting that ‘as a country progresses through the industrialization process, its reliance on petroleum and electricity increases and the importance of biomass decreases’ (Hosier and Dowd 1987).

Factors like costs of cylinders, appliances and connections may affect the willingness of households to switch from fuel wood to commercial alternatives (Horst and Hovorka 2008). Though income has important role in energy choice, but it becomes irrelevant if energy carriers and technologies are not physically available. Therefore, it is very essential to have efficient distribution system to reduce the energy poverty (Treiber, Grimsby and Aune 2015). There are many factors which determine the use of cooking fuels. Broadly, the physical, economic and social barriers have greater role to play. Besides, these broad factors, the factors like convenience of cooking fuel is also important determinants in accepting cooking fuel especially rural areas. The choice and acceptance of cooking energy is strongly influenced by the convenience of using it which is embedded in socio-cultural settings of the population (Atanassov, 2010). The type of food typed, quantity prepared and type of stoves also influence the choice of cooking fuel. In addition, taste and time are other factors in household cooking fuel use. Availability of fuel is also one of the main determinants of having more than one fuel in stock. In addition, it is also influenced by the seasonal availability of firewood and agriculture residuals which leads to multiple stove use. Therefore, fuel affordability and availability are major issues in terms of fuel choice (Treiber, Grimsby and Aune 2015). Geography and climate variations are also important factors which affect firewood availability, asset ownership, and living standards. It is argued that the pressure on forest is less if the growth in education and nonfarm assets took place. Contrary

to it, if the growth in traditional assets as live stokes is likely to put press on forest (Baland, Bardhan, Das, Mookherjee, Sarkar 2010.)

It is often argued that the access to infrastructure services have influential role in choosing clean cooking fuels. It suggests that clean cooking fuels and electrified household is also related, it is observe that the electrified household tend to adopt modern cooking energy across all level of income. Further, access to an improved water source also enhances clean cooking fuels (World Bank 2003). In one studies in Bangladesh, factors like economic inability to afford clean energy, availability of other source of energy have considerably played an important role in determining the household cooking energy. It also reveals the gender aspect in firewood collection process where female spend most of time (Hassan M.K, Halder P, Pelkonen P and Pappinen A 2013).

The rate of urbanization also influence the household energy consumption pattern, as the urbanization increases, there is lesser chances of firewood use demand but increasing charcoal consumption (Arnold, Kohlin and Persson 2006). The process of fuel choice and fuel switching decision is affected by variables like household expenditures, education, urbanization, electrification status. It is observed that household size influence and increase in all fuels use; but less likely to influence in fuel switching. The level of infrastructure services like electricity, water supply and roads are also important in determining household cooking energy use (World Bank, 2003). In India and China, the factors like energy prices, energy access, income, urbanization and availability of local fuels are main drivers of fuel transition (Pachauri and Jiang 2008). The factors such as household income, energy prices, costs and quality of supply, and urbanization along with demographic differences and geographic variations are major determining factors in household energy choices. In comparative study of India and China, it is found that level of education of head of the household have positive relation in clean fuel choices (Pachauri and Jiang 2008). Household's capacity such as access to resources like labor, land, and money along with the other factors, such as access to "Common Property Resources(CPRs)" and the availability and price of substitute fuels also determine the response to fuel wood shortage (Arnold, Kohlin and Persson 2006).

As per World Bank, the LPG use is depend on household size and is best understood as a probability. In other words, the probability of using LPG increase with household size as it is economically beneficial to use. In fact, large households are more likely to use both biomass and clean fuels. Opposite is in the case of kerosene i.e. high kerosene use for small households. Therefore, “the tendency for small households to opt for kerosene instead of LPG is indirect evidence of the critical importance of start up costs in deterring greater LPG usage in low-income settings” (World Bank 2003).

Leach (1992) expressed apart from income level of households, the major obstacle to attain higher rung of energy in developing countries is due to poor access situation. Viswanathan and Kumar (2003) said that “high distribution costs for remote and sparsely populated areas make the supply of commercial energy a difficult task in rural India” (p.1022). In their analysis using household data collected by NSSO during 1983-2000 in India, found a huge difference in rural and urban expenditure share of clean fuel (kerosene, gohar gas and LPG) and also seen significant differences across the states. For instance, in rural India the share for clean fuel increases from 20% in 1983 to only 23% in 1999-2000 whereas urban share increases nearly double from 39% in 1983 to 70% in 1999-2000. They found the main culprit to these low shares of expenditure on clean fuel is low economic status and lack of access to clean fuel. It is given that there is a significant correlation between expenditure on clean fuel and economic status and its growth overtime. Lack of access to clean fuels due to high initial cost for adoption and pro-urban and pro-rich subsidy is also noted.

However, a study conducted in urban India (Farsi et al 2007) highlight the significant proportion of urban households that rely on biomass fuel as their primary cooking energy besides greater access to cleaner fuel and equipments compared to rural India. Moreover, study also reveals that those household lives in metros and larger cities have the higher probability of using cleaner fuel because of greater accessibility. Budget constraints and fuel prices are other important determinants of fuel choice as higher the income, higher is the probability of switching from biomass to cleaner fuel and substitution effect occurred due to relative prices of the fuels. Overall, households with better economic condition, education, and empowered of women are more likely to use modern efficient fuel in urban India.

The same is true for adoption of improved cooking stove, an immediate policy measure to reduced IAP, which increases efficiency and reduction in quantity of fuel used. A recent study (Lewis and Pattanayak 2012) which review the various empirical studies explore a wide range of socioeconomic determinants of fuel and stove choice such as income, education, household size, location, religion, social groups, credit access, and fuel prices (also see Mekonnen & Kohlin, 2009; Rao & Reddy 2006). Both, adoption of improved cooking stoves and clean fuels choice are directly associated with income and education (head of household and female) whereas socially marginalized status Scheduled Caste (SC)/Scheduled Tribe (ST) are indirectly associated. The study also showed that for either adoption of improved stoves or decision to purchase an improved cooking stove were positively influenced by, in addition, fuel wood price, household size, and availability of credit and negatively influenced by age of household head and price of LPG. Further, switching from biomass fuel to cleaner fuel is enhanced for households with female head, access to electricity and higher female education; however, worse for male education and households working in agricultural and casual labor. Better off households (Behera Dash & Yadav 1991; Duflo et al 2008) and households resides in urban places (Lewis and Pattanayak 2012) have high probability to use cleaner stove that use clean fuel. Several studies also expose that apart from income there is a high and positive correlation between using clean fuel with women empowerment, education, sex of the head of household and accessed to electricity. Kishore & Spears (2012) analysis of women's intra-household status and fuel choice conceived an interesting result. They found that having a firstborn girl child relative to firstborn boy child lowers intra-household status and associated with three-fourths of a percentage reduction in the probability of using clean fuel. Since having girl is a curse in Indian society.

A study conducted in South India (Gupta and Ravindranath 1997) based on fuel-device combination found that device's efficiency is a crucial factor in determining total cost of device choice. The result of the study shows that, in rural area, poorest section of the society uses traditional biomass stove and price of the wood-burning stoves is the highest. Firewood burned in the efficient Astra stove (improves biomass stove) was observed to be lowest total cost whereas LPG and biogas were the most expensive option. However, firewood burned in traditional stove was expensive than subsidized kerosene options. On the other hand, in urban

area, due to relatively higher price of firewood subsidized kerosene is the cheapest option. Even though, Astra stove option is between subsidized and market price kerosene, with or without subsidy kerosene remains cheaper option than traditional firewood stove combinations. Interestingly, traditional firewood stoves combination is even higher cost options than subsidized LPG but lower to market price LPG.

Although, it is said to be very effective in reduction of IAP by switching from wood, dung, charcoal, or crop residue to more efficient modern fuels, access to these alternatives is very limited for most of the developing countries. This is because of the fact that relationship between reliance on traditional fuels and poverty is a two way (Bruce et al 2011). The financial constraints of the poor households do not permit switching to more efficient, cleaner fuels (Bruce et al 2000). Whereas, on the other hand, using traditional fuels leads to adverse health affect, women time and opportunities loss for income generation which in turns inhibits the households attempt to escape from poverty (Lewis & Pattanayak 2012). According to their study, it is almost impossible to achieve complete switching of fuel in near future as IEA estimates that up to 2030 more than 3 billion people will rely on solid fuel.

6. Firewood as fuel in mountain areas:

Forests provide multiple environmental services viz., recharging of mountain aquifers, conservation of soil, and prevent floods and drought. They provide habitat for wildlife and also help in maintaining ecological condition and natural evolution process of diverse flora and fauna. Globally, mountains constitute 24% of land which supports around 12% of world population. Mountains are source to water, forest, energy and centre of biological, cultural, tourism (Price 2004). Most of the people from low areas are dependent on resources which have their origins in mountain areas.

Further, most of the rural population is dependent on forests for their livelihood and extract resources in the form of fuel wood, timber and other forest produce which have huge economic value (National Environment Policy 2006). It is identified that mountain ecosystem are extremely vulnerable to climate change (Fischlin et al. 2007) because of its exposure to climate change. Rural livelihood and their economic activities are closely linked with environment and nature, therefore rural population are sensitive to climate change and their variability (IPCC 2014). Rural and mountainous living in remote areas people especially

indigenous communities are more sensitive to the impact of climate change (Lama and Devkota 2009). In mountain region, some of the common environmental issues are deforestation, safe drinking water, land degradation and landslides etc. and the region is very sensitive to climate change. Degree of vulnerability of mountain environment also intensify with the climate change and leads issues like poor soil and poor vegetation (Iyngararasan, Tianchi, Shrestha, Mool, Yoshino and Watanabe 2004)

It is considered that firewood extraction is one of the major causes of deforestation in Himalayan region (Chettri, Sharma, Deb and Sundriyal 2002). Indicators like the proportion of population where solid fuel is the primary source of fuel is used to assess the environmental sustainability (Rehfuess, Mehta and Pruss-Ustun 2006). In mountain areas, firewood is the only source of fuel for people due various reasons like its easy availability and it is simple to use. Accessibility of clean energy in these areas is very difficult due to various socio-economic and physical structures (Chettri, Sharma, Deb and Sundriyal 2002). Firewood is the main source of fuel (energy) and it is likely to continue in future. It is recognized that access, communications, and energy are key issues in the sustainable development of mountain areas. The provision of credit schemes will be also an important to promote the development of access, communications and energy in mountain areas. Mountains are vital sources of energy of diverse forms especially potential of hydropower generation due to its topography. Therefore, its development and potential alternative source of fuel (energy) in mountain areas has been putting different aspect on sustainable development debate in recent times (Kohler, Hurni, Wiesmann, and Klay 2015). The concept like ‘energy poverty’ has been gaining significance in recent times. Domestic energy poverty refers to a situation where a household does not have access or cannot afford to have the basic energy or energy services to achieve day to day living requirements. These requirements can change from country to country and region to region. The most common needs are lighting, cooking energy, domestic heating or cooling. Energy poverty is defined as:

A person is in “energy poverty” if they do not have access to at least:

- (a) the equivalent of 35 kg [LPG](#) for cooking per capita per year from liquid and/or gas fuels or from improved supply of [solid fuel](#) sources and improved (efficient and clean) cook stoves
- ; and
- (b) 120kWh electricity per capita per year for lighting, access to most basic services (drinking water, communication, improved health services, education improved services and others) plus some added value to local production

An “improved energy source’ for cooking is one which requires less than 4 hours person per week per household to collect fuel, meets the recommendations [WHO](#) for air quality (maximum concentration of CO of 30 mg/M³ for 24 hours periods and less than 10 mg/ M³ for periods 8 hours of exposure), and the overall conversion efficiency in higher than 25%.”⁷

Fuel switching is defined “as the choice between traditional solid fuels and modern non-solid fuels. In simple, all households belong in one of three ‘exclusive fuel switching’ categories”:⁸

- “No switching – the household consumes only solid fuel(s)”
- “Partial switching – the household consumes both solid and non-solid fuels”
- “Full switching – the household consumes only non-solid fuel(s)”

7. Policy Measures:

Generally, most of the study conducted related to biomass energy use so far has only one important fundamental objective; to address the issues relating to adverse impact on health, environment, forest depletion, etc. and resulting policy measures to enhance reduction in using biomass fuel and switching to modern fuels. Various policy recommendations are derived from several studies such as increasing availability of efficient fuels (LPG, Kerosene, Electricity) to poor section of society by means of subsidies, better supply of modern fuels, improvement in credit access, and introducing and better commercialization of improved stoves. Apart from various policy implications drawn, little has done by some NGOs,

⁷ https://en.wikipedia.org/wiki/Energy_poverty

⁸ World Bank, 2003

development agencies and government. Only option available to cure all this adverse effect is complete transition to modern efficient fuels. However, it is impossible in near future⁹, Mishra et al (1999b) and Bruce et al (2011) expressed the need for government and NGOs intervention to strengthen the programmes to promote inexpensive improved biomass stoves that are more fuel efficient and less smoky than traditional biomass stoves. In addition, Parikh et al (2003) highlight the importance of generating awareness, promoting literacy as a policy measures. Moreover, ensured partition between cooking and living area, proper ventilation, and smoke averting behavior even if households have to use biomass fuels in order to reduced smoke exposure (Heltberg 2004). Affordability is the major hindrance for large scale uptake of modern energy services in most of the developing countries (Heltberg 2005). So, research and innovation for low cost household energy technologies is suggested rather than subsidy on modern energy where upfront cost for adopting is beyond reach of targeted poor households. In such a scenario subsidy might favor the well to do households and results in draining funds of government. Precisely, expressed that policy of improved stoves and LPG uptake should be promoted where firewood is ample and expensive respectively. Different studies (WHO 2006; Bruce et al 2011) gives interventions policy like adequately design, installed, and maintained improved stoves, improving living environment such as better stove location, housing construction, and ventilation and changing behavior of fuel use such as drying fuel, using pot lids, and reducing exposure of children by keeping away from kitchen. Also gives enabling policy like generating demand for improved cooking stoves and clean fuel through various channels such as regularization, reduction in taxes and provision for subsidy, raising awareness of health and other benefits, making products suitable for poor households. Thus, provided intervention and enabling policy is the short term and immediate measure to reduce exposure of IAP. In their review of various cost-effective analysis and cost-benefit analysis of different studies (Ezzati and Kammen 2002) found that intervention policy like improved stoves, stove location, better ventilation, changing behaviors of fuel used and enabling policy like generating demand for clean stoves and fuel through regulation, raising awareness of health advantages leads to overall benefit to the society.

⁹ Insufficient purchasing power, easily available biomass fuel and lack of basic infrastructure are frequently noted

The major obstacle to the adoption of improved cooking stoves and clean fuel choice are high initiation cost for adoption and installation and unreliable supply (Heltberg 2005). In view of the association between clean fuel choice and adoption of improved cooking stoves with education, location and credit access, it is suggest that strengthening information and communication aspects of social marketing and extending supply chain into rural areas and introducing microfinance intervention might be useful for increase adoption (WHO 2006; Lewis and Pattanayak 2012). Leach (1992) suggests that improving access to modern fuels and equipments by reducing unreliable supply and high equipment cost should be promoted by various measures. The study gives success story for two countries, for instance, due to increased in supply of kerosene and kerosene stoves in Addis Ababa, the capital of Ethiopia in 1983, demand of wood fuel decline by 40% and around 70% of the households used kerosene and its stove by 1986. Apart from promoting higher level of education, Farsi et al (2007) argued that greater empowering of women, promotion of general economic development and subsidization of LPG and equipment price will bring a higher fuel substitution. However, caution that subsidy in LPG price if not establish in a proper fashion might benefit the richer section of the society. Policies and suggestions are many but employing these might not be feasible as expected if not study the prevailing situation and problems of the area of interest in a precise way.

Apart from smoke from cooking fuel, various socio-economic and demographic factors also influenced the risk of various diseases. Mishra et al (1999b) analysis in India shows that age, sex, level of education, religion, and household economic indicator such as place of cooking have a significant effect on prevalence of TB in persons 20 years & above. They found that older persons, males, Muslims by religion, and low levels of educated person are more likely to suffer from TB. In addition, prevalence of TB is much lower for those persons living in households with a separate kitchen compared to those living in households without a separate kitchen. Similarly, a case control study conducted in Nepal (Prokhrel et al 2010) also exhibit apparent effect of religion, income, place of residence, family history of TB, and environmental tobacco smoke on prevalence of TB. Regarding asthma in elderly population, demographic factors such as age and sex, socio-economic factors like education and standard of living have a significant effect on prevalence (Mishra 2003a). Further, prevalence of “acute respiratory infection (ARI)” in children is significantly influence by age, sex, and

birth order of child, mother's age at childbirth, household standard of living (Mishra 2005b). The study shows that older children, girls, higher order birth, and children of older mothers are less likely to suffer from ARI. Standard of living, an economic indicator of the households also influence as children living in higher standard of living households are less likely to suffer from the disease.

CHAPTER 3

STUDY AREA AND CONCEPTUAL FRAMEWORK

1. A historical journey of Sikkim:

History is all about human migration, similar is in the case of Sikkim. The history of Sikkim dates back to 1641. At that time, Sikkim was inhabited by small group of tribes called Lepcha and later other groups of people like Bhutia, Nepalese entered Sikkim. The available literature tells that Sikkim was inhabited by three tribal group viz., Naong, Mon and Tsong. Later these groups of people were replaced by Lepcha people who regarded to enter Sikkim somewhere from Tibet and Burma. The other narratives considered that Lepchas were migrated in Sikkim from the foothills of Assam and Upper Burma of North east India (White 1909; Das 1983). However, some scholars claims that Sikkim was predominated by groups of people like Tsong, (also referred as Limbu/Subba) Magar etc. In fact, the term ‘Sikkim’ originated from the Limbu word ‘*Sukhim*’ meaning ‘new house’; original settlers from the Tsangpo valley in Tibet. The erstwhile kingdom of Sikkim cannot be study without mentioning the role of Limbu in the erstwhile dynasty. The second Chogyal (meaning king in Sikkim) Tensung Namgyal had married to a daughter of Limbu Raja by name Yo Yo Hang (Risley 1894; Coelho 1971).

Later in the period, it is considered that the other groups of people entered the territory of Sikkim from neighboring areas. For example- it is regarded that Bhutia (mostly Tibetan) came from Tibet region and Bhutan. It is considered that Bhutia people gave the term ‘*Denzong*’ meaning ‘valley of rice’ for Sikkim and they themselves considered as ‘*Denzongpas*’. (White 1909; PCA Census of India 2011). Nevertheless, Lepchas are regarded as the earliest inhabitants of Sikkim and call themselves as ‘*Rong-pa*’ which means ‘ravine folk’ (Risley 1894; White 1909; Coelho 1971).

In 18 th century, there was confrontation between Sikkim and Nepal which is considered as the watershed development in the history of Sikkim in which Nepal captured some territory of Sikkim. In 1812, with the intervention from British India, Sikkim was able to recapture its lost territory. The British India had their own interest on Sikkim and Bhutan driven by trade

and political interest in Tibet as these two countries (Sikkim was a kingdom then) were the gateway to Tibet. On 10 February 1817, a treaty was signed between Sikkim and British East India Company which compelled Sikkim to surrender all its rights related to foreign power. Further, it also granted free permission to trade with Tibet area. Later, on 17 March 1890 due to Anglo-Chinese convention, this status of British India put it to an end and both Chinese and Tibetans recognized British government as protectorate for Sikkim (Risley 1894). It also demarcated boundaries between Sikkim, Chinese and Tibet (Das 1983; Coelho 1971).

As per Census of 1891, the total population of Sikkim was 30,000 where one-third were constituted by Lepchas and Bhutias and rest by the Limbus, Gurungs, Khambus, Rais, Magars, Murmis and other small groups. It was broadly divided into three distinct divisions:

- a. The Lepchas or the '*Rong-pa*', the oldest and the perhaps the original inhabitants.
- b. The '*Kham-pa*', the immigrants from the Tibetan province of Kham which is also known as 'Bhutias', and
- c. The limbus along with Gurungs, Murmis etc who have believed migrated from the province of Tsong, Tibet.

At the end, it was the Bhutias which established the dynasty in Sikkim.

2. The Chogyal Dynasty of Sikkim:

During 17 th century, the territorial extend of Sikkim was vast unlike present which is the result of many historical events like intrusion from Bhutan, Nepal, Tibet and the British India. Its northern part was extended beyond Phari in Tibet, in the eastern side, near Paro in Bhutan, Timar river in Nepal the western side and in southern side near the borders between Bengal and Bihar. (PCA, Census of India 2011). In early 18 century, Sikkim ceded its territory to Bhutan and Nepal. The lost territory recovered after the '*Treaty of Sugauli*' between Sikkim and Nepal and the '*Treaty of Titalia*' (1817) between Sikkim and British India ending Anglo-Gorkha war (Risley 1894; Coelho 1971).

It is regarded that the formal kingdom system in Sikkim started in 13 th century by Guru Tashi, the exile prince of the Minyang dynasty of Tibet – considered as Guru Tashi, the exile prince of the Minyang dynasty of Tibet, is generally accorded the status of being the founder

of the kingdom in Sikkim. He subsumed all the inhabited tribes in his kingdom and started to rule Sikkim. The king or raja was generally called '*chogyal*' and Phuntsog Namgyal (1642-1670) was appointed as the first '*chogyal*' or raja or king of Sikkim at Yoksum the first capital of Sikkim by three Tibetan Lamas (Risley 1894; Coelho 1971). He was the descendent of '*Khye Bhumsa*' meaning the superior of ten thousand heroes, a settler of Chumbi valley. He signed a treaty with Lepcha chieftain at Kabi Lungchok which brought new ties of brotherhood between the Lepchas and the Bhutias. This 'blood treaty' between Lepchas and Bhutia promoted the growth of multiple ethnic societies which also saw the conversation of animist-practiced Lepchas into new form of Lamanism of Tibetans. This development had an important socio-economic implication on the lives of community (Risley 1894). Although at present, majority of Lepchas are Bhuddhist but they still worship nature - mountain, forest, and river (Coelho 1971). Later in 18 the century, British also had influence on Lepcha community which converted of some of them into Christianity (Das 1983).

Chogyal Tensung Namgyal (1670-1700) was the second '*chogyal*' of Sikkim and he shifted capital from Yoksum to Rabdanse. He appointed many councilors mostly Lepcha and Bhutias which later came to known as '*Kazis*'- who enjoyed special privileges and immense power. Third '*chogyal*' was Chador Namgyal (1700-1717), considered as distinguished in Tibetan literature and Buddhist learning. Fourth '*chogyal*' was Gyurmed Namgyal (1717-1733). He was forced to fortify Rabdanse then capital of Sikkim because of the fear of Gorkhas and Bhutanese attack. Phuntsok Namgyal II (1733-1780) was the fifth '*chogyal*' of Sikkim who introduced the yearly taxation system (PCA, Census of India 2011). In his reign, Gorkhas under the leadership of Raja Prithvi Narayan Shah of Nepal and Bhutanese invaded Sikkim which led to the substantial settlement of Nepalese in Sikkim (Das 1983). However, Bhutan after negotiation withdrew to its present frontiers. In 1775, a peace treaty with Nepal was signed promising there will be no further attack. Later they violated the treaty and captured land in western part of Sikkim. Further, they able to occupied large territory under the reign of sixth Chogyal Tenzing Namgyal (1780-1793). This event ends with the intervention from Chinese which led the Sino-Nepal treaty where Sikkim lost part of its territory to Nepal. The seventh Chogyal was Tsudphud Namgyal (1793-1863) who shifted capital from Rabdantse to Tumlung mainly because of security reason as Rabdantse was too close to hostile Gorkhas (Coelho 1971; PCA, Census of India 2011). Under this period,

Sikkim ceded Darjeeling to British India as a recreation resort, a part of Bengal under British government on annual subsidy of Rs.3000 (Risley 1894; Coelho 1971; Das 1983). In 1850, this annual subsidy of Rs 3000 was increased to Rs 6000 under eight '*chogyal*'- Sidekeong Namgyal (1863-1874) (Coelho 1971). Further, it was increased to Rs 12000 annually (Risley 1894). Thutob Namgyal (1874-1914) was the ninth '*chogyal*' and he shifted capital from Tumlung to present capital Gangtok in 1894. The tenth '*chogyal*' Sidkeong Tulku (1914-1914) could not live long. Tashi Namgyal (1914-1963) became the eleventh '*chogyal*' of Sikkim who exclaimed many reforms in Sikkim. He was the '*chogyal*' of Sikkim when India got independence from British in 1947 and credited in getting special status of protectorate for Sikkim (PCA, Census of India 2011). During this time, when British left India, there was drastic change in the ethnic composition of Sikkim resulting the Nepalese composition accounted seventy five percent whereas Lepcha and Bhutia constituted fourteen and eleven percentage respectively. The Bhutia community emerged as strong in dominant social class as they enjoyed high bureaucratic post '*kazis*' during British rule (Das 1983). The twelfth and last '*chogyal*' was Palden Thondup Namgyal (1963- 1973). Under his reign, there was political unrest as people of Sikkim started to demand end of monarch system and beginning of democratic form of government. Later, on 16th May 1975 Sikkim became 22nd state of India Union by the 38th amendment of the constitution of India and adopted democracy form of government ending century old monarchy system (PCA, Census of India 2011).

3. Physical and climatic setting of Sikkim:

Sikkim is the 2nd smallest state of India in terms of area after Goa. It has an area of 7096 sq km. and density of 86 sq km. It is located between 27°00'46" to 28°07'48" north latitude and 88°00'58 "to 88°55'25" east longitudes. Sikkim a landlocked state is rugged and entirely mountainous in its topography. The northern part of Sikkim is mostly covered with snow and has some restricted area it strategically shares borders with China. Sikkim is bounded by vast stretches of Tibetan plateau in the north, the Chumbi valley of Tibet and the kingdom of Bhutan in the east, the Nepal in the west and Darjeeling district of West Bengal in the south. In west, the main mountain range is Singelela which runs from Kanchendzonga and have some major peaks like Sandakpu, Phalut etc. This range also has one important '*pass*' (also referred as '*la*') called Chewabhanjyag which leads to Nepal. On the other hand, the Chola

mountain range in east Sikkim is home to many important '*passes*' viz, Nathula, Jelep, Thankala, Yak-la etc. The important '*passes*' in north Sikkim adjacent to Tibet are Bamchho la, Kongra la and Sese la. In between these mountain ranges, Sikkim is drained by its two important glacier-fed rivers viz., Teesta and Rangeet system (Coelho 1971; Rislely 1894).

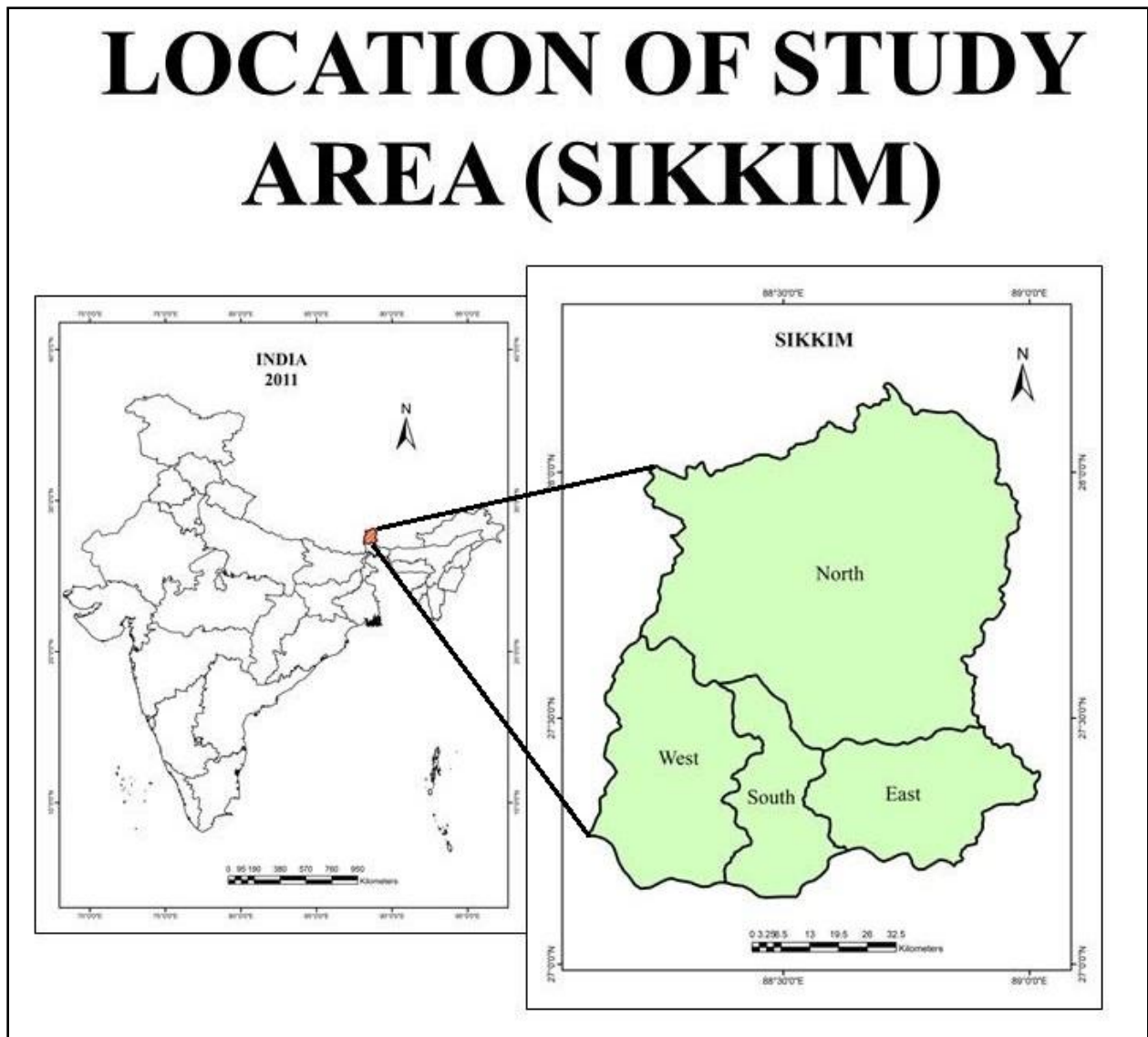
Sikkim is a part of the Eastern Himalaya which is endowed with rich biodiversity (Rislely 1894). The Eastern Himalaya extends from Central Nepal in the west and Myanmar in the east comprising southeast, Tibet in China, Sikkim, North Bengal, Bhutan and North East. Being a part of Eastern Himalaya, Sikkim is entirely mountainous and hilly in nature. It is listed as one of the 34 global biodiversity hotspots. The tiny state is endowed with rich natural resources, represented in its huge floral and faunal biodiversity with 47 per cent of area under forests, which is one of the highest in India both in terms of per capita forest cover as well as the proportion of geographical area of the state (Sikkim HDR 2014). Sikkim is a part of inner mountain Himalaya with elevation ranging from 300 meters to 7000 meters and most importantly Sikkim is the home of third highest peak of the World i.e Kanchenjunga (8598 meters). The snowcapped mountainous physiographic of Sikkim is also endowed with some excellent glaciers like Zemu, Lhonak, Talung etc. (PCA, Census of India 2011). Sikkim is also gifted with famous glacial lakes like Gurudongmar, Tsongpo and Khecheopalri (Sikkim HDR 2014).

Sikkim has diverse climatic condition which displays a varied range of ecological conditions from tropical moist to temperate and alpine zones—in such a small geographical area (Sikkim HDR 2014). Altitudinal variation is important in determining the climate and weather condition of Sikkim. Major portion of the North District is home to many glaciers, high altitude peaks which mostly covered with snow and it shares border with Tibet Autonomous Region of China. Therefore, driven by the climatic condition and harsh topography, major portion of North District is uninhabited area and experience cold weather condition throughout the year. This district has the lowest density among the other districts i.e., 10 persons per sq km. (Census of India 2011). On the other hand, lower region of state experience warm and humid weather condition. In the month of July-August, Sikkim records maximum average temperature in the range of 21-26 degree Celsius while minimum average temperature varies from 6 to 8 Celsius in December-January. The mean annual rainfall

ranges between 2000 mm. to 4000 mm and the annual mean rainfall is 2739 mm (PCA, Census of India, 2011).

Due to physiographic settings, Sikkim is extremely vulnerable to many natural hazards especially earthquake and landslide. Sikkim falls under the seismic zone of IV which may cause high destructive. For instance, the earthquake of September 18, 2011, with a magnitude of 6.8 RS (rector scale) which had epicenter in boundary between Sikkim (India) and Nepal caused the worst damage with three aftershocks of 5.7, 5.1, and 4.6 followed within 30 minutes (Sikkim HDR 2014).

Map 3.1: Location map of study area (Sikkim)



4. Administrative set up:

Sikkim is divided into four district viz., North, East, South and West district and nine sub-districts. In terms of economic activities, people of Sikkim are mostly depending on agriculture and governmental services.

Table 3.1: Revenue Block (Village), Forest Blocks, Statutory Towns and Census Town in Sikkim

State/District/Sub - Division	No. of (Revenue Block) Village	No. of Forest Blocks	No. of Towns (including Census Town)
Sikkim	400	51	9
1. North district	45	10	1
(i) Chungthang Sub-Division	5	4	
(ii) Mangan Sub-Division	40	6	1
2 West district	112	13	2
(i) Gyalshing Sub-Division	65	8	1
(ii) Soreng Sub-Division	47	5	1
3 South district	136	12	2
(i) Namchi Sub-Division	91	7	2
(ii) Ravong Sub-Division	45	5	
4 East District	107	16	4
(i) Gangtok Sub-Division	65	10	3
(ii) Pakyong Sub-Division	26	3	
(iii) Rongli Sub-Division	16	3	1

Source: Census of India, 2011.

5. Socio-economic and demographic and profile of Sikkim:

5.1 Demographic profile:

Sikkim is the least populous state in India with the total population of 610,577 (Census of India 2011). Around 74.85% of total population of Sikkim resides in rural areas and 25.15% in urban areas. The population distribution is uneven across four districts of Sikkim. For instance, North District with largest area has density of only 10 persons per square kilometer, while East District has density of 297 persons per square kilometer which means 46 per cent of the state's population resides in East District. Overall, the density of Sikkim is 86 persons per square kilometer (Census of India 2011; Sikkim Human Development Report 2014).

Table 3.2: Population growth in Sikkim at each census from 1901 to 2011

Year	Persons	Males	Females
1901	59014	30795	28219
1911	87920	45059	42861
1921	81721	41492	40229
1931	109808	55825	53983
1941	121520	63289	58231
1951	137725	72210	65515
1961	162189	85193	76996
1971	209843	112662	97181
1981	316385	172440	97181
1991	406457	216427	190030
2001	540851	288484	252367
2011	610577	323070	287507

Source: Census of India, 2011.

Table 3.3: Basic information of Sikkim, Census of India, 2011

Districts	Population	Density (persons per sq km.)	Sex-Ratio	Literacy	ST	SC	Urban Population (%)
NORTH	43,709	10	767	78.01	65.7	2.25	10.62
EAST	283,583	297	873	83.85	27.66	5.4	43.19
SOUTH	146,850	196	915	81.42	28.19	4.12	14.44
WEST	136,435	117	942	77.39	42.38	4.35	3.85
SIKKIM	610,577	86	890	81.42	33.8	4.63	25.15

Source: Census of India, 2011.

As per Census of India 2011, the total population of Sikkim is 610577 which is the least among the Indian states. In terms of population distribution among its four districts, East District has the highest number of population (283,583), followed by South District (146,850), West District (136,435) and North District (43,709). The East District is also the most densely district (297 sq. km) whereas North District is the least dense among districts (10 sq. km).

The sex ratio for Sikkim is 890 and highest sex ratio is recorded in West District (942) whereas lowest is in North District (767). Overall, the sex ratio has improved from 875 in 2001 to 889 in 2011. In case of child sex ratio (0–6 years), the ratio is 944, which is higher

than the national average of 914 (Census of India 2011). Sikkim has high literacy rate of 81.42. Among districts, East District has high literacy rate of 83.85 % which is closely followed by South District (81.42%).

In terms of Scheduled Caste (SC) and Scheduled Tribe (ST) population, Sikkim has high percentage of ST population (33.8) than SC population (4.63%). It is recorded that North District has high percentage of ST population (65.7%) among the districts. In case of SC population, East district recorded high (5.40%) followed by West (4.35%) and South District (4.12%).

The urban population of Sikkim is recorded 25.15%. The urban population is recorded in East District (43.19%) which is considerably high than other districts viz., South (14.44%), North (10.62%) and West (3.85%). The imbalance in urban population in Sikkim is mainly due to disparity in economic and bureaucratic set up. Among the four districts of Sikkim, East District is the most developed. The major reason behind the development of East District and growth of urban population is due to factors like maximum concentration of industries, offices, educational institutions and the location of state capital- Gangtok which offers various services to people.

Community wise, Nepali, Lepcha and Bhutia are predominant in Sikkim. However, in urban areas many *plainsmen* have also settled and they are mostly engaged in business and services. It can be said that, culturally and traditionally Sikkim is the land of many communities and they all are living harmoniously.

5.2. Agriculture:

Traditionally, agriculture is the backbone of Sikkim's economy (Coelho 1971). The nature of terrain and varied climatic condition determines the agricultural practices. As majority of Sikkim lives in rural areas and they mostly engage in agricultural practices though not in extensive scale. The total geographical land under agricultural land is around 15.36% which further has been declining due to conversion of land in other activities like infrastructure development. Agriculture land is fragmented and farming is still in rudimentary in nature characterized by lack of farm mechanization, limited irrigation etc. Agriculture production is low because of nature of terrain, small and fragmented land holding size and socio-economic

condition of the farmers as most of the farmers fall under the small and marginal farmers (PCA, Census of India 2011). Being an entirely mountainous region, land resource for cultivation is extremely scarce in Sikkim as only 11% of the total geographical area, at an altitude of a little less than 2,000 meters, is available for cultivation (Sikkim HDR 2014).

In 2015, a watershed development in farming sector took place as Sikkim fully became the first 'organic' state of India. In other words, farming practices in Sikkim is completely based on 'organic' methods with complete ban on entry of fertilizers in Sikkim.

5.3. Literacy:

Literacy rate of Sikkim is impressive and above nation average. As per Census of India 2011, the literacy rate of Sikkim is 82% where 87% and 76% for male and female respectively. Among the districts, East district (83.85%) stands first in terms of literacy rate followed by South district (81.42 %), North district (78.01%) and West district (77.39%).

5.4. Rural area:

About 74.85 % of population lives in rural area. The economy of rural areas is mostly driven by agriculture. It is very important to understand that rural areas for overall development. To excel in grass root level in rural areas, the strong and transparent local government is essential. The decentralization process needs to be effective to give meaning to 'cooperative federation' structure of Indian union.

5.5. Urban area:

The urban population constitutes only 25.15% in Sikkim. There are around 153,578 urban populations which are distributed in eight statutory towns and one census town. The capital city Gangtok (100,286 persons) is the most populated urban area followed by Namchi (12,190) and Rangpo (10,450). The district wise distribution of urban population in Sikkim is unevenly distributed as East District with urban population 43.19% constitute top position which is followed by South District (14.44%), North District (10.62%) and West District (3.85%).

Table 3.4: Population and number of towns, 2011

Name and civic administration status of Towns	Population of Towns		
	Persons	Males	Females
NORTH DISTRICT	4,644	2,456	2,188
1. Mangan (NP)	4,644	2,456	2,188
WEST DISTRICT	5,248	2,710	2,538
2. Gyalshing (NP)	4,013	2,054	1,959
3. Nayabazar (NBA)	1,235	656	579
SOUTH DISTRICT	21,199	10,822	10,377
4. Namchi (M.Cl)	12,190	6,166	6,024
5. Jorethang (NP)	9,009	4,656	4,353
EAST DISTRICT	122,487	64,285	58,202
6. Gangtok (M.Cor)	100,286	52,459	47,827
7. Singtam (NP)	5,868	3,097	2,771
8. Rangpo (NP)	10,450	5,555	4,895
9. Rhenock (CT)	5,883	3,174	2,709
Total	153,578	80,273	73,305

Note : NP -Nagar Panchayat, NBA- Notified Bazaar Area, M.Cl- Municipal M.Cor- Municipal Corporation and CT-Census Town

Source: Census of India, 2011.

5.5.1. Size, Class and status of Towns:

As per Census of India, 2011, there is only one town which falls under class I with population size of 100,000 and above and there is no town under classes of II and III. The Gangtok Municipal Corporation is the only town which belongs to class I. The Namchi Municipal Council and the Rangpo Nagar Panchayat fall under class IV and towns like Jorethang Nagar Panchayat, Singtam Nagar Panchayat and Rhenock Census Town comes under class V. Further, towns like Mangan Nagar Panchayat, Gyalshing Nagar Panchayat and Nayabazaar Notified Bazaar Area comes under class VI.

Table 3.5: Size, Class and status of Towns

Class	Population size	Number of Towns
Class I	100,000 and above (referred to a city)	1
Class II	50,000 to 99,999	
Class III	20,000 to 49,999	
Class IV	10,000 to 19,999	2
Class V	5,000 to 9,999	3
Class VI	Less than 5,000	3

Source: Census of India, 2011.

5.5.2. Municipalities:

The history of the Municipal Corporation Act in Sikkim dated back in the year 1975 when Sikkim became a state of India. However, this Municipal Corporation Act of 1975 could not function properly, therefore it ceased in 1985. In 2007, the state government enacted Sikkim Municipalities Act of 2007 which declared Gangtok as Municipal Corporation, Namchi as Municipal Council and Mangan, Gyalshing Jorethang, Rangpo and Singtam as Nagar Panchayats (NP) by the Urban Development & Housing Department (UD&HD) and the first election was held in 2010 as per this Act i.e Sikkim Municipalities Act of 2007 (PCA Census of India 2011).

Table 3.6: Municipal Corporation, Municipal Council and Nagar Panchayat Wards in Sikkim

District	Name of Statutory Town	Number of Ward
North District	Mangan (Nagar Panchayat)	5
West District	Gyalshing (Nagar Panchayat)	5
South District	Namchi (Municipal Council)	7
	Jorethang (Nagar Panchayat)	5
East District	Gangtok (Municipal Corporation)	15
	Singtam (Nagar Panchayat)	5
	Rangpo (Nagar Panchayat)	5

Source: PCA, Census of India, 2011.

5.5.3. Tourism:

Sikkim is endowed with natural and lush environment. Its location in Eastern Himalaya makes it home to many exotic plants and animal species. It has many natural areas which leaves anyone to fall in love to this place. In addition to such heavenly environment, the rich and diverse cultural setting and peaceful political environment makes Sikkim more attractive to tourists/travelers/trekkers. Sikkim offers many tourist spots ranging from mountaineering, trekking, paragliding, snowy peaks, waterfalls hot springs, snow fed glacial lakes, river rafting etc. The cultural diversity of Sikkim is rich and attracts tourists, for instance- 'monasteries' 'gumpas', holy caves and tribal practices.

Tourism sector in Sikkim has been growing fast contributing revenue generation and employment generation. It regards as the fastest growing sector in Sikkim (PCA, Census of

India 2011). In recent years village tourism with home stay facilities has been flourishing rapidly. The concept of village tourism is very positive move from the state government to explore the livelihood, cultural richness of rural Sikkim.

6. Forest and environment:

History of human civilization is linked to the forest which is integral to the livelihood of people. They act as a regulator of climatic and weather phenomenon both at regional and world level, besides the direct benefits of livelihoods and sustenance (SHDR, 2014). It is closely interlinks with climate change, carbon stocks or emissions. It is estimated that deforestation and land degradation contributes to about 20% of global CO₂ emissions. (Ravindranath, Sharma, Sagadevan, Jayaraman, Munsu 2012). As per IPCC report 2007, forest acts as pool for carbon sink and reduces the emissions from deforestation and degradation.

Sikkim is rich in its forest resources with 44.1% (3127 sq km) of the state's areas under forest cover ranging from the Tropical to Temperate and Alpine zone. The forest resource of Sikkim also includes its rich herbs, shrubs, medicinal plants, orchid and bamboos. The forest of Sikkim is home to many endangered animals like red panda, snow leopard, Musk Deer, Blue sheep etc (Census of India 2011). In Sikkim, forest and nature have very important place in the daily lives of people- it has socio-cultural implications. The history, culture and tradition of Sikkimes communities are integrally linked with the forest and nature. The communities of Sikkim especially tribal people worship forest and nature in every ritual. The close dependence on nature/forest and their indigenous way of resource management helps to conserve rich forest resource (Sikkim HDR 2014).

According to the "Forest Survey of India (FSI)" (2013), the area under dense forest in Sikkim has slightly declined during the period 2001 to 2003 which again increased from 2003 onwards. The area under scrub vegetation increases from 2001 onwards but it is observed to decrease from 2005 onwards (Ravindranath, Sharma, Sagadevan, Jayaraman, Munsu 2012). Since 1995, Sikkim has been actively introducing numerous policies on forest for its healthy growth. As per the FSI (2013), among north eastern state Sikkim is the only state that has been able to keep its forest cover intact since 2009 and also recorded zero net loss of forest cover in all districts. There are strict rules and regulations for forest conservation measures.

The felling of trees and export of timbers is strictly ban in Sikkim. Even to fell the private tree, one need to take permission from state forest department, only dead and dying trees are allowed to cut down with prior permission (Tambe and Arrawatia 2012).

7. Major forest and environment policies in Sikkim, since 1995:

Sikkim is pioneer in advocating environment protection, conservation and management. Sikkim has initiated numerous steps and achieved many milestones to make Sikkim – a green state. Among these initiatives and achievements some important are follows (Environmental Initiatives of the State Government 1994-2016, Govt. of Sikkim):

1997: Banned the use of non-biodegradable materials like plastics, poly-bags, and biomedical/ chemical wastes through legislation.

1999: On 5 th June 1999, Sikkim conceptualized the concept of '*Smritivan*' – a noble idea of planting tree in memory of near and dear ones with ultimate aim to make 'green' Sikkim.

2001: Prohibition of commercial activities in unique terrestrial & aquatic ecosystem of wetlands/lakes to preserve the heritage and fragile ecology of the State.

2005: Framed "Sikkim Ecology Fund and Environment Cess Act, 2005" which levy cess on industries, traders and consumers for using non-biodegradable materials.

2006: Launched a noble programme called 'State Green Mission' on 27 February 2006 to make state green by planting trees and other conservative measures.

2009: On 25 June 2009 a unique idea of 'Ten Minutes to Earth' initiated by government to dedicate ten minutes in plantation, protection and conservation of Mother Earth.

2009: the concept of 'Heritage Tree' initiated to protect large trees having girth above 25 feet as a conservative measure.

2001: The Government of Sikkim imposed ban on commercial collection of medicinal Plants but barring collection by villagers of wild medicinal plants for local consumption.

2013: On the 15th day of June, 2013, the government of Sikkim declared June 15-30 as '*Paryavaran Mahotsav*' or the 'Environmental Festival' is a people's programme celebrated throughout the State from 15th to 30th June every year a campaign for the green Sikkim. It

has now integrated the state's flagship programmes viz. State Green Mission and Ten Minutes to Earth.

2014: On 19th December 2014 imposed prohibition on “the manufacture, sale and use or bursting of all types of firecracker including any sound emitting or illuminating type of firecrackers within the State of Sikkim”.

2015: On 27th January 2015 government imposed prohibition on the burning of agricultural waste, leaves, litter, paper wastes and garbage in state. However, it does not cover the use of processed agricultural wastes, leaf litter and garbage as fuel and controlled burning of forest litter for the purpose of scientific management of forest fires.

2016:

- i. Sikkim becomes the first state in the country to be declared as full-fledged Organic State and declared 18th January of every year as Organic Day in Sikkim.
- ii. Government has imposed ban on use of packaged drinking water bottles in any government functions and meetings. Use of filtered water or large reusable water dispensers or reusable water bottles during government functions encouraged. Further, State Government has imposed ban on sale and use of disposable items such as cups, plates, containers etc made from Styrofoam throughout the State with immediate effect.
- iii. Khangchendzonga National Park (KNP) fulfils UNESCO's criteria for both natural and cultural heritage, and is the first site in India to be awarded the status of a mixed World Heritage Site on 17 July 2016 by the World Heritage Committee in Istanbul, Turkey.

As per State Human Development Report 2014, forest covers 47% of the geographical area of the state within which 93% is reserve forest and 6.6 percent is under protected forest. Sikkim is home to one national park and seven wildlife sanctuaries having total area of 2,179 sq. km (31% of state geographic area) (Sikkim HDR 2014). Dependence on firewood as fuel is high in Sikkim where on an average; a household needs around 7,400 kg fuel woods every year. Around 80% of firewood demand is met from reserve forests and around 19% is from private forests. It is estimated that average fuel wood consumption for a household is over 20

kg per day where its requirement varies seasonally; for example, daily household usage peaks in winter at 25 kg. Tourism sector especially eco-tourism and trekking has been flourishing resulting high demand of firewood. Children and women are chief firewood/fodder which is mostly carried in winter season. The reason behind the engagement of children in firewood collection process may be the timing of winter school vacation. Women especially in rural areas have responsibility of running household affairs like cooking, firewood collection etc (Sikkim HDR 2014).

Table 3.7: Forest Products Collected by Respondents for Own Consumption (in %)

Districts	Fuel wood	Litter/ leaves	Fodder	Wild edibles	Bamboo stems	Medicinal plants/herbs	Bamboo shoots	Other
EAST	88	73	81	54	81	54	46	0
NORTH	92	79	71	100	38	54	25	40
SOUTH	97	97	90	68	81	71	81	30
WEST	97	89	89	68	76	59	43	0
ALL	97	86	84	71	70	60	50	20

Source: Sikkim Human Development Report, 2014.

As majority of people in Sikkim resides in rural areas, the increasing population has put pressure on resource like forest and agriculture. Forest is an important source of livelihood and ecological security in rural Sikkim. The dependence on forest for services like firewood, fodder, medicinal plant is high in Sikkim. Overdependence on forest leads to exploitation and it has irreversible environmental and socio-economic implications. Therefore, it is suggestive to use forest in a sustainable manner.

8. Statement of problem and need of the study:

With vast forest area, Sikkim has occupied important role in providing environmental services. Sikkim with total population of 610,577 is the smallest Indian state in terms of population size where 74.85% lives in rural area while 25.15% lives in urban area. Firewood as household cooking fuel is high in Sikkim especially in rural areas. Overall, 52.5% of population depends on firewood for household cooking where rural areas constitute 70.8% (Census of India 2011). Only 29.9% of rural population is access to clean household cooking energy (DLHS-IV, Fact sheet, 2012-2013). Above all, not much research work has done in Sikkim especially pertaining to man-environment relation which is important for sustainable mountain development.

Table 3.8: Percentage of households by availability of major fuel used for cooking in Sikkim, Census of India, 2011

Name of Districts	Total/Rural/Urban	Total number of households	Firewood	LPG/PNG	Kerosene
North District	Total	8,903	64.14	26.32	5.43
	Rural	7,951	70.86	20.48	4.19
	Urban	952	7.98	75.11	15.76
East District	Total	61,122	34.95	57.54	6.1
	Rural	32,212	62.02	31.97	4.42
	Urban	28,910	4.79	86.03	7.98
South District	Total	30,246	61.87	33.13	3.07
	Rural	25,476	72.29	23.71	1.99
	Urban	4,770	6.23	83.44	8.87
West District	Total	27,860	77.26%	19.16	1.76
	Rural	26,731	80.02	16.72	1.47
	Urban	1,129	11.96	76.79	8.68

Source: Census of India, 2011.

Table 3.9: Types of fuel used for cooking in Sikkim: Firewood, 2001-2011(in percent)

Year	Total	Rural	Urban
2001	64.6	73.3	3.6
2011	52.5	70.8	5.3

Source: Census of India, 2011.

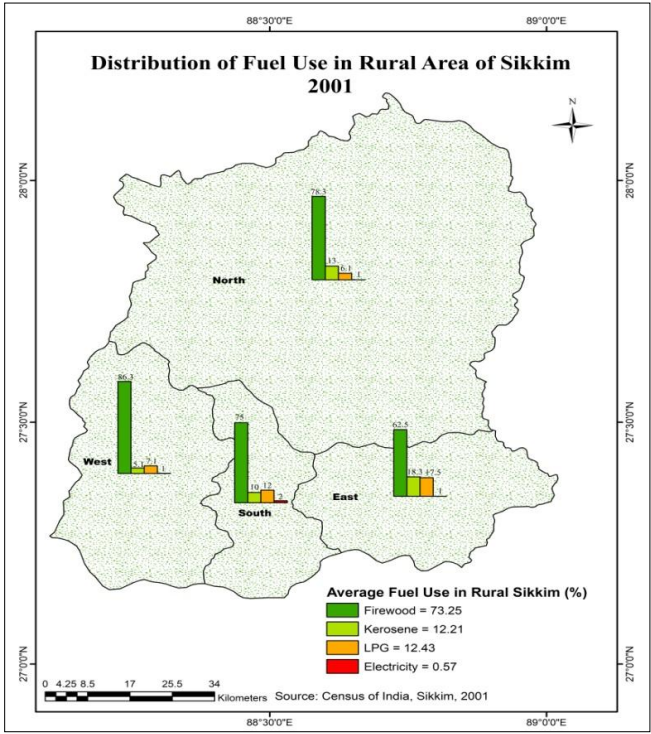
Table 3.10: Types of fuel used for cooking in Sikkim: LPG, 2001-2011(in percent)

Year	Total	Rural	Urban
2001	18.8	12.4	63.9
2011	41.3	24.3	85.1

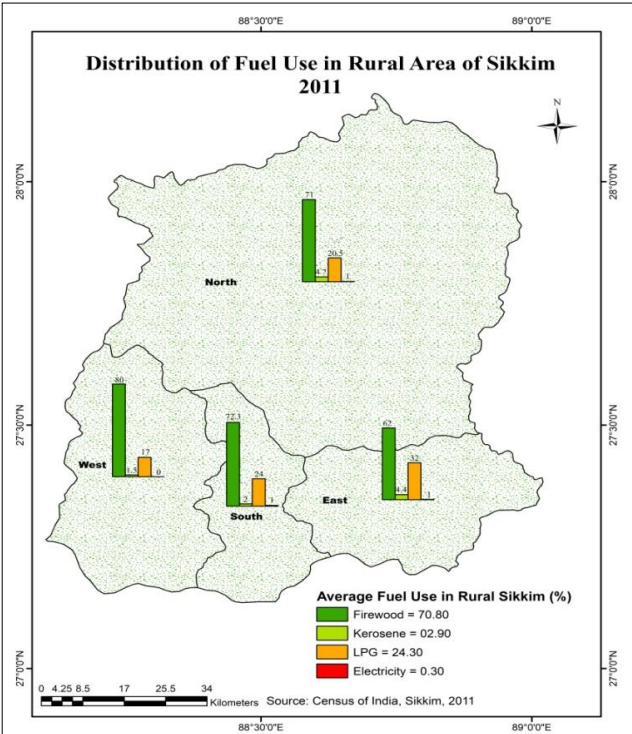
Source: Census of India, 2011.

Map 3.2: District wise distribution of fuel use in Rural area of Sikkim in 2001 and 2011.

Map 3.2. a.



Map 3.2.b.



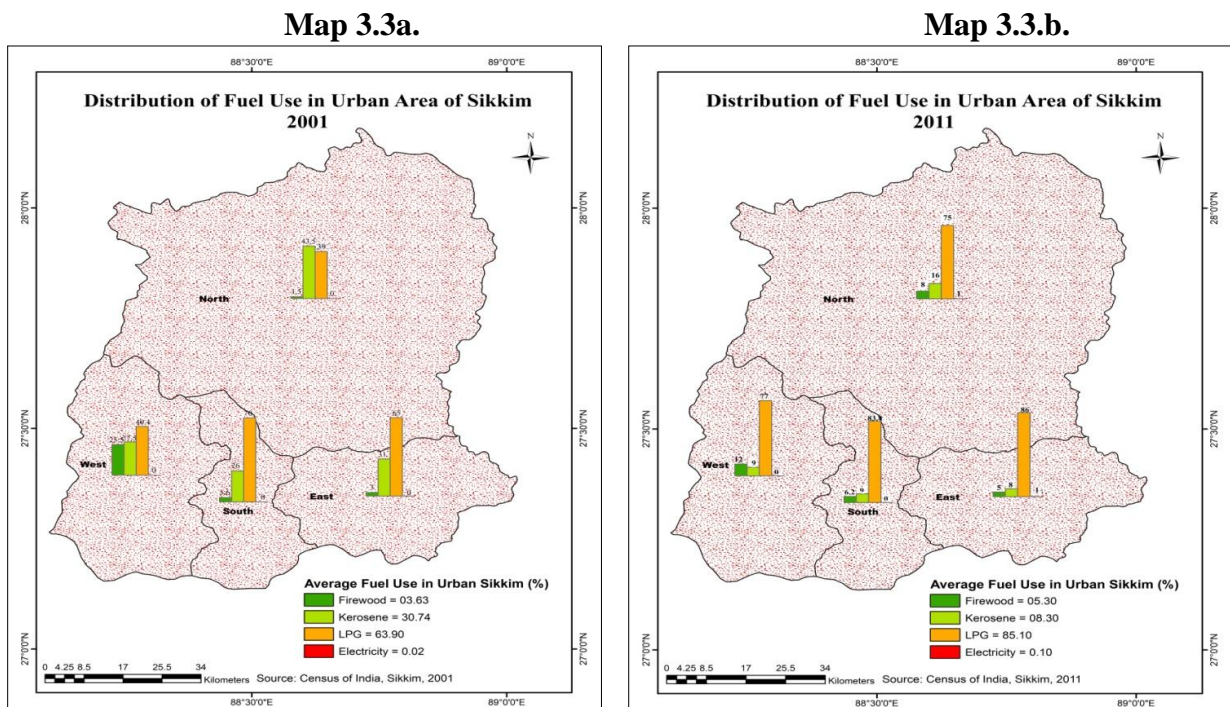
Above given two maps 3.2.a. and 3.2.b. show that the level of various type of fuel uses in rural Sikkim in two time periods i.e 2001 and 2011 based on census data of 2001-2011. Here, four types of fuels use have shown viz., firewood, kerosene, LPG and electricity because these are the prominent in Sikkim.

District wise it is observed that there is no significant change occurred between the two periods of time in firewood, kerosene and electricity use in rural Sikkim. In other words, there is no significant change has observed in firewood, kerosene and electricity use in rural areas of four districts. However, the average percentage uses of fuels have been observed change in kerosene and LPG. In 2001, kerosene use was 12.21% which is considerably come down to 2.9% only in 2011. On the other hand, the percentage of LPG use has observed significant rise in 2011 i.e. 24.3% from 12.43% in 2001. However, this percentage use of LPG is still low in rural Sikkim in 2011. There has been no significant change has been observed in other fuels use like firewood and electricity between the two census periods in rural areas. However, the district wise analysis observes that there has been considerable

change in the percentage use of LPG in all the rural areas while no significant change is observed in other fuels use.

In a nutshell, though there has been rise in the percentage use of LPG in rural areas of Sikkim in time period 2001-2011, the percentage use of other fuels has shown no change especially in firewood and electricity use. The percentage use of LPG in 2011 is still low i.e only 24.3%. The major concern is that the use of firewood as cooking fuel has shown no difference which is still high at 70.8% in rural area. This figure needs to bring down and the percentage use of LPG needs to increase.

Map.3.3: District wise distribution of fuel use in Urban area of Sikkim in 2001 & 2011.



The maps no.3.3.a and 3.3.b. tries to capture the picture of fuel use in urban areas in the period between 2001 and 2011. Unlike rural areas, there is high percentage use of LPG in urban Sikkim and low percentage use of firewood in all the urban areas of districts. In an urban aggregate level, the percentage use of LPG has significantly increase i.e 63.9% to 85.1% while the percentage of kerosene use come down considerably from 30.74% to 8.3% in the time period 2001-2011. In other fuels use like electricity and firewood only marginal

change has been observed surprisingly, the percentage of firewood use has increase in urban Sikkim in time period 2001-2011.

The district wise observation revels that in all the urban areas there has been considerable increase in the percentage of LPG use. In contrary, the use of kerosene has been significantly decreased in all districts. However, in case of firewood use, except West District, all other districts observed marginal increase in the percentage use of firewood; this needs to be examined.

Comparatively, there is wide rural-urban gap in type of fuel use in Sikkim especially in case of firewood and LPG use. The level of LPG is far better off in urban areas of Sikkim which may be due to factors like infrastructure and efficient distribution system. However, for the comprehensive fuel access to all, such differences need to minimize at the lowest level. There should not be discrimination in provision of providing LPG services especially in rural areas. Therefore, the government’s policy of free/subsidized LPG to poor people needs to re evaluate so that the schemes reaches to those who are entitled i.e BPL household.

Table 3.11: Percent distribution of urban, rural and total households by cooking fuel, Sikkim, 2015-16, NFHS-4

Cooking fuel	Urban	Rural	Total
Electricity	2.3	1.4	1.7
LPG/natural gas	90.7	40.8	57.4
Biogas	0	0.1	0.1
Kerosene	3.9	0.4	1.5
Coal/lignite	0	0	0
Charcoal	0.1	0.5	0.3
Wood	2.8	56.7	38.8
No food cooked in the house	0.3	0.1	0.2
Total	100	100	100
Percentage using clean fuel for cooking (Electricity, LPG/natural gas, or biogas)	92.9	42.4	59.1
Percentage using solid fuel for cooking (Includes coal/lignite, charcoal, wood, straw/shrubs/grass, agricultural crop waste, and dung cakes)	2.9	57.1	39.1

Table 3.12: Percentage of household using clean fuel for cooking, NFHS-4

Districts	Rural	Total
North	39.4	48.8
West	38.4	41.4
South	42.5	52.5
East	46.2	70.7
Sikkim	42.4	59.1

Table 3.13: Use clean fuel for cooking (percentage) - DLHS-IV (2012-13)

Districts	Total	Rural
North	33.2	27.6
East	72.7	57.5
South	28.6	20
West	27.1	24.1
Sikkim	46.7	29.9

Table 3.14: Percentage of household by fuel used for cooking in Sikkim, 2012-13

Fuel used for cooking	Total	Residence	
		Rural	Urban
Liquefied Petroleum Gas (LPG)	45.9	29.3	88.7
Electricity	0.5	0.3	1.1
Kerosene	2.6	1.8	4.8
Wood	50.2	68.1	4
Others	0.1	0	0.2

Source: DLHS-4, 2016.

Table 3.15: Percentage of type of fuel used for cooking in Sikkim, NFHS-3 (2005-06)

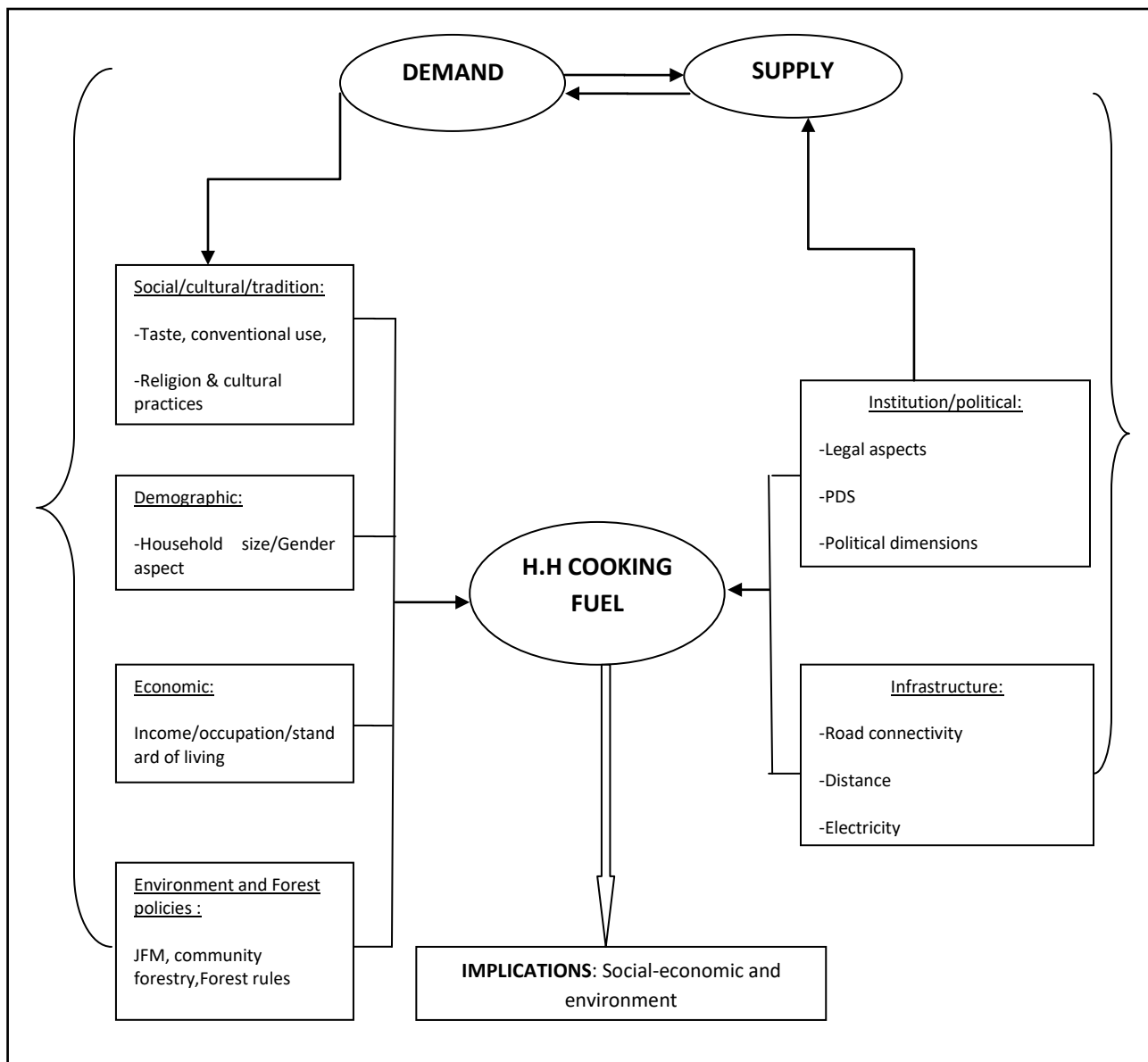
	TOTAL		PLACE OF RESIDENCE			
	TYPE OF FUEL		RURAL		URBAN	
	CLEAN ENERGY	BIOMASS ENERGY	CLEAN ENERGY	BIOMASS ENERGY	CLEAN ENERGY	BIOMASS ENERGY
Sikkim	47.8	52.2	34.5	65.5	100	0

9. Research gap:

It is found that in most of research and policies is based on the ‘supply’ side mechanism which mostly tends to ignore the grass root or household demand side and their socio-economic attributes. There are many socio-economic, demographic, cultural, environmental

and geographical factors which influence the household cooking energy choice. The success of ‘supply side’ is only possible if we understand the ‘demand side’ of household. Therefore it is very important to understand the demand and supply side of household cooking energy mechanism and their interplay for the effective policy formulation and implementation process. Further, the equally important aspect is to understand the ‘capability’ of people to access and afford the clean energy and its sustainability in long run. Hence, fuel interventions need to consider more from demand side intervention than supply side intervention.

10. Conceptual framework:



11. Objectives:

- i. To examine the type of household cooking fuel use across socio-economic groups.
- ii. To analyze the determinants of household cooking fuel.
- iii. To examine the intervening factors associated with fuel switching from unclean to clean cooking fuel across geographical area.
- iv. To investigate the gender dimension in household cooking fuel use.
- v. To critically evaluate the state's policies/programmes on household cooking fuel.

12. Research questions:

- i. What are the prominent socio-economic factors that determine the household cooking fuel in rural settlement?
- ii. What are the household fuel consumption patterns i.e., both household food consumption and non-food consumption across socio-economic groups in rural Sikkim? Whether non-food consumption fuel use has any influence on determining household cooking fuel for food consumption?
- iii. Whether the general notion of household size on household cooking fuel use has its relevance in rural household of Sikkim? How the consumption of household cooking fuel varies across ethnic communities along with their cultural practices and fuel requirements?
- iv. What are the geographical factors that have been playing major role in determining the household cooking fuel use? How the household cooking fuel consumption distribute across geographical areas and altitude wise with micro-climatic factors?
- v. Whether the use of firewood has any significance change/impact over forest cover and land use pattern? How the Joint Forest Management system has been playing a role in regulating forest resource along with providing firewood?
- vi. Are there any gender issues in household cooking fuel use? What is the level of household characteristics in respect with household cooking fuel and its health risk?
- vii. What are the problems associated with the provision of providing alternative household cooking fuel?

- viii. Whether capability aspect of accessing and affording clean household cooking fuel is an issue?
- ix. What are the intervening factors that have been associated in fuel switching from firewood to clean cooking fuel? What are the compelling factors that have been forcing rural people to depend on firewood for cooking energy? Is it the issue of capability or conventional practices?
- x. Whether the people are equipped with the use/knowledge of modern cook stoves?
- xi. What are the implementation process of government plan and polices regarding household cooking fuel in rural areas? What is the level of awareness of people about such changing plans and policies of government?

13. Study area:

Based on the percentage of fuel use and the socio-economic criteria villages from West District, North District and East District, South district were selected as study area. The selection of study area is based on data from the census of India, 2011. The study was carried in the months of March, April and May 2017.

14. Sampling methods:

Total sample size- 600 Household: West-200, North 150, South-150, East-100.

15.1. North district:

Three villages from North District where the percentage of household cooking energy is more or less similar to rural North District as a whole.

Table 3. 16. Selected villages from the North district, Sikkim

VILLAGE	NO. OF H.H	FIREWOOD	LPG	KEROSENE
NORTH DISTRICT	7,951	70.9	20.5	4.2
Lachen	338	73.3	19.6	5.4
Shipgyer	225	64.1	6.8	4.4
Namok	132	71.9	23	1.5

Source: Census of India, 2011.

Samples from all three villages with the help of ‘equal proportion’ method

Sample size - 150. Total household of three villages- 695

Therefore, $150/695 = 0.215$

Table 3. 17: Number of sampling household from each village

VILLAGE	NO. OF H.H	No. of H.H *0.215	Sample size
Lachen	338	0.215	72
Shipgyer	225	0.215	48
Namok	132	0.215	30
	695		150

Source: Census of India, 2011.

15.2. East district:

1. Three villages from East District where the percentage of household cooking energy is more or less similar to rural East District as a whole.

Table 3.18: Selected villages household from East district, Sikkim

VILLAGE	NO. OF H.H	FIREWOOD	LPG	KEROSENE
EAST DISTRICT	32,212	62.02%	4.42	31.97
Lingzey (Assam)	430	65.1	31.6	2.2
Pacheykhani (Dikling)	115	60.2	39	0
Subanedara	409	59.6	28.4	9.4

Source: Census of India, 2011.

Samples from all six villages with the help of ‘equal proportion’ method

Sample size- 100.

Total household of six villages- 954

Therefore,

$100/954 = 0.104$

Table 3.19: Number of sampling household from each village

VILLAGE	NO. OF H.H	No. of H.H *0.104	Sample Size
Lingzey (Assam)	430	0.104	44
Pacheykhani (Dikling)	115	0.104	14
Subanedara	409	0.104	42
	954		100

Source: Census of India, 2011.

15.3 West district:

Six villages from West District where the percentage of household cooking energy is more or less similar to rural West District as a whole.

Table 3.20: Selected villages household from West district, Sikkim

VILLAGE	NO. OF H.H	FIREWOOD	LPG	KEROSENE
WEST DISTRICT	26,731	80.02%	16.72%	1.47%
Gerethang	239	80.2	15.1	1.7
Barnyak	503	81.1	15.3	2
Mabong	237	81.4	12.1	5.6
Karthok	128	81.7	8.4	1.5
Chakung	380	79.1	18.7	1.6

Source: Census of India, 2011.

Samples from all six villages with the help of ‘equal proportion’ method

Sample size - 200. Total household of five villages- 1487

Therefore, $200/1487 = 0.134$

Table 3.21: Number of sampling household from each village

Villages	No. of Household	No. of H.H * 0.124	Sample size
Gerethang	239	0.134	32
Barnyak	503	0.134	67
Mabong	237	0.134	31
Karthok	128	0.134	19
Chakung	380	0.134	51
	1487		200

Source: Census of India, 2011.

15.4: South district:

Three villages from South District where the percentage of household cooking energy is more or less similar to rural South District as a whole.

Table 3.22: Selected village from South district, Sikkim

VILLAGE	NO. OF H.H	FIREWOOD	LPG	KEROSENE
SOUTH DISTRICT	25,476	72.3	23.7	2
Chuba	153	71.2	26	0
Barnyak	121	73.3	25	0.8
Rong	139	70.8	27.7	1.5

Source: Census of India, 2011.

Samples from all three villages with the help of 'equal proportion' method

Sample size- 150.

Total household of six villages- 413

Therefore,

$150/413 = 0.36$

Table 3.23: Number of sampling household from each village

VILLAGE	NO. OF H.H	No. of H.H *0.104	Sample Size
Chuba	153	0.36	55
Barnyak	121	0.36	45
Rong	139	0.36	50
	413		150

Source: Census of India, 2011.

16. Methods:

The study is based on household survey. The secondary data are derived from the Census of 2001-2011, NFHS and DLHS to justify the research proposal. The Census data of India 2011 has been used to identify the sample village and sample size in the study area. The survey was conducted randomly in pre-identified sample villages which were selected on the basis Census of India 2011 data. The number of household in a village were surveyed by taking road as benchmark i.e household located near road and household located far away from in the sample village.

To examine the intervening factors associated with fuel switching from unclean to clean cooking energy across geographical area.

No switching – the household consumes only solid fuel(s)

Partial switching – the household consumes both solid and non-solid fuels

Full switching – the household consumes only non-solid fuel(s)

The mixed method (qualitative and quantitative) method has been used to understand the underlying factors in accessing various fuels use in rural Sikkim. The Geographical Information System (GIS) has been used to show the location and comparative picture. The “likert scale”¹⁰ has been used to know the perception of people about various fuels use. For instance:

Perception

Rank	Availability (%)	Affordability (%)	Easy to use (%)	Efficiency (%)	Pollution (%)
1					
2					
3					
4					
5					
Total					

Availability (1=easy, 5=difficult), Affordability (1=easy, 5=difficult), Ease of Use (1=easy, 5=difficult),
Efficiency (1=efficient, 5= inefficient), pollution (1=least, 5=most).

16.1: Statistical methods:

Cross-tabulation, Multinomial regression, Logistic regression have been used. The statistics software i.e. Statistical Package for Social Sciences (SPSS) has been used.

¹⁰ a scale used to represent people's attitudes to a topic.

CHAPTER 4

SOCIO-ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF STUDY AREA (RURAL SIKKIM)

1. Introduction:

Sikkim is a tiny state located in the Eastern Himalaya and one of the states of North East India. Sikkim is the smallest state in terms of population (6,10,577) and second smallest state in terms of area (7096 sq.km). Sikkim has only four districts and the rural-urban divide is wide where 74.85 % of total population of Sikkim resides in rural areas and 25.15 % in urban areas.

Table 4.1: Population, density and urban population of Sikkim

Districts	Population	Density (Persons per sq km.)	Urban Population (%)
North	43,709	10	10.62
East	283,583	297	43.19
South	146,850	196	14.44
West	136,435	117	3.85
SIKKIM	610,577	86	25.15

Source: Census of India, 2011.

The population distribution is uneven across four districts of Sikkim; for instance, North District with largest area has density of only 10 persons per square kilometer, while East District has density of 297 persons per square kilometer which means 46% of the state's population resides in East District. Overall, the density of Sikkim is 86 persons per square kilometer (Census of India 2011; Sikkim Human Development Report 2014).

The study area covers all the four districts. However, the number of sample village, sample size varies considering the percentage of firewood and LPG use and population size. Therefore, among total 14 sample villages, 5 villages are from West district and 3 villages each from East, North and South districts. Likewise, the sample size also varies across four districts.

2. Study area and sample size of the study area (Rural Sikkim):

Table 4.2: Descriptive Statistics of the study area

District	Village	Sample (n)	Percent Household (%)	Total
East	Assam Lingchey	44	7.3	100
	Pachey khani	19	3.2	
	Subaneydara	37	6.2	
North	Namok	30	5	150
	Shipgyer	48	8	
	Lachen	72	12	
West	Gerethang	32	5.3	200
	Chakung	51	8.5	
	Barnyak	67	11.1	
	Mabong	31	5.2	
	Karthok	19	3.2	
South	Rong	50	8.3	150
	Chuba	55	9.2	
	Bermoik	45	7.5	
Total	14	600	100	600

Source: Field survey.

The fourteen villages have been selected as field study area from four districts. The study areas i.e villages are selected on the basis of sample technique i.e equal proportion method based on the population size and the percentage of cooking fuels use across four districts. These villages are selected on the basis of secondary source of data i.e. Census of India, 2011. It is because of the variation in population composition across the districts, the numbers of villages as study areas are also varies. Therefore, the number of study area or sample area i.e villages varies across four districts. In other words, the selections of villages among four districts are not equal. For example, East district, South district and North district has three villages each as study area whereas in West district five villages are selected as study area.

Likewise, the sample size is also varies from 100 sample size in East district, 150 sample size from South and North district each; and 200 sample size from West district with aggregate sample size of 600 from four districts. The sample size and the sampling percentage can clearly observe in above table 4.2. The lowest sample size from study area is 19 each from

Packeykhani (East district) and Karthok (West district). On the other hand, Lachen (North district) and Barnyak (West district) has large sample size of 72 and 67 respectively.

3. Background of Sample villages:

3.1. East District:

3.1.1 Assam Lingchey:

Assam Lingchey is located in the East District of Sikkim. It is located approximately 12 km away from the state capital Gangtok. Its topography is sloppy in nature and its physical extent is large where population composition is diverse. It is broadly divided into upper, middle and lower Assam Lingchey. The Upper Assam Lingchey is climatically cool and mostly dominated by tribal people like '*Bhutia*', '*Sherpa*' whereas in lower and middle Assam Lingchey, population is inhabited by diverse population groups like '*Subba*' (*limbu*), '*Rai*', '*Chettri*', '*Bahun*' etc. The lower and the middle Assam Lingchey is characterized by temperate climatic condition. The village is socio-economically developed where basic public services like bank, health, education, infrastructure and transport systems are available. Most of the household belongs from APL family and engaged in government services. The entire village have '*puccha*' house. Although the government service is the primary activity in the village; majority of households practices agriculture in small scale, if not large. The village is connected with all weather-mettled road however the condition of road is largely govern by the physical factors like rainfall, landslide etc.

In terms of LPG use, distribution system is good where there is fixed system of delivering in weekly basis, mostly in every Saturdays. However, people dependent on both firewood and LPG in cooking food. The firewood is mostly used in preparing fodder for animals (cow, goats, pigs, chicken) whereas LPG is mostly used for cooking food. It is observed that every household uses firewood along with LPG irrespective of income/status of household primary because of animal rearing, household agriculture practices and food consumption pattern. It is come to know that most of the village communities belongs to '*Rai*', '*Bhutia*' and resides in high altitude where firewood easily available from both private forest public forest. Most of the surveyed households were non-vegetarian and mostly consumes pork, beef, chicken, mutton where their most preferred food item is rice, '*roti*' sometimes. The firewood

collection is time consuming process even if it is easily available. The decreasing trend of forest covers as reported by respondents.

3.1.2. Pacheykhani (Dikling):

Pacheykhani is located in the East District of Sikkim which is 8 km away from sub-division Pakyong. The topographical structure of village is sloppy and climatic condition is temperate type where maximum temperature reaches 22 Celsius. The infrastructures like road, post office, electricity, health and education, community centers are available in village. Although road connectivity is good but it is hard to find taxi services which runs only in morning and evening time. The population composition is mostly dominated by '*Bahun*' and '*Chettri*' community where almost 95% of household have '*pucca*' house.

The LPG distribution system is regular or available but with no fixed timing of delivery. As per respondents, the forest cover has been increasing because people do not go to forest to collect firewood as a result they think forest area has grown up and becoming dense. The significant numbers of people from this village are employed in Pharmaceutical Companies which are located nearby area like Rorathang, Kumrek (Rangpo). In agriculture sector, large scale agriculture practices are hardly done due to unavailability of man force/manpower/worker etc. So, small scale farming is common with rearing of animals like cow, oxen, pigs, goats, chicken etc.

3.1.3. Subanedara:

It is located 8 km away from Rogli- a small market area in East District. It is situated at the top of the hilly terrain which is characterized by cool climatic condition. With no road connectivity in the village, life is hard hit by services like education, health, and infrastructure however road construction is in process. The village is accessible by '*kucchha*' or unmetalled road which was under construction and has to go through a small river with no bridge over it (even not a '*kucchha*' bridge) which is scary especially in monsoon period. The village is inhabitants by '*Magar*' and '*Gurung*' community and mostly engaged in agriculture practices like vegetable farming, animal rearing. Cardamom is most common in this village. In fuel use, most of the villagers are dependent on firewood for the cooking purposes because of its easy availability. The LPG use in the village is low despite its

availability in nearby '*Rongli*' bazaar where there is scheduled LPG delivery system. Taking filled LPG cylinder from '*Rongli*' bazaar is a cumbersome work which requires manpower, time and physically demanding which results high economic and opportunity cost.

3.2. South district:

3.2.1. Rong

Rong, a small village is situated in South Sikkim, about 7 km away from Namchi. Rong is inhabitant mostly by '*Magar*', '*Gurung*' and '*Rai*' community. Agriculture and government services are the primary activities that most of the people engaged in. The village is sloppy in nature and reserved forest nearby area. Then cultivation of maize, '*daal*', vegetables are most common agriculture practices with rearing of cows, pigs, goats, chicken etc. The village is accessible by road but it is hard to find taxi services except in morning and evening time. Some of the household are located far away from road side and these household are exclusively dependent on firewood for cooking purposes. However, despite majority of household uses LPG cylinder, the use of firewood is equally in use mainly because of the livestock. Despite the considerable number of LPG use, the LPG distribution service is totally absent from the agencies/governments. Usually, villagers are dependent on local taxi driver to get the filled LPG cylinder, charging each cylinder for minimum Rs 100. Some of the household are beneficiaries of the Government of Sikkim's LPG cylinder distribution system. One respondent state that it cost Rs 9000 to get new LPG connection with one gas stove and two cylinder.

3.2.2. Chuba

Chuba village is located 19 km away from Namchi and it is divided into Upper, Middle and Lower Chuba. The village is sloppy in its topography but accessible by '*pucca*' road. The village is mostly dominated by '*Gurung*', '*Lepcha*', '*Subba*' etc community. The agriculture products include maize, vegetables, cardamom. The LPG users are very less in number with around 70% of people dependent on firewood for cooking purposes. There is no free LPG distribution from government like it used to be in earlier days where current LPG users are beneficiary. The transport system is not so well developed despite accessible by '*pucca*' road. The taxi service is available only in morning and evening time and it is hard to find taxis in between morning and evening. There is no LPG distribution vehicle system in the

village. Those who use LPG have to travel to Namchi to refill the LPG cylinder or they have to pay Rs 150 to local taxi drivers to get cylinder. Villagers collect firewood from their private as well from nearby reserved forest area which is within 2 km premises; and reason given by villagers why they are still dependent on firewood is easy availability of firewood. In lower Chuba, most of the household are from Nepal and they have settled long back ago. They are mostly engaged in agriculture practices usually in landlords' land.

3.2.3. Bermoik:

Bermoik is located in South District of Sikkim. It is around 9 km from Singtam– a town in East Sikkim. However, it is far from its sub-division Namchi which comes under its administrative jurisdiction. The population composition is diverse where there is no particular community is dominant in the village. The government service and small scale agriculture is the primary activities of villagers. The infrastructure services like road, health, education, post office, community services are good in shape. However, there is no regular LPG distribution system. People have to depend on unscheduled arrival of LPG vehicle from Namchi with no fixed date and timing of its arrival. Therefore, most of the time people need to get LPG from Singtam or Majitar (East District), nearby towns for LPG cylinder.

3.3. North District

3.3.1. Lachen:

Lachen is located 50 km from sub-division Mangan, in North District. Lachen is cold place where winter is mostly covered by snow. Lachen has its own system of governance which is called '*dzumsa*'¹¹ headed by '*pipon*'¹². The Indian 'panchayati raj' institution is invalid in these two places of Sikkim. The people of Lachen are called '*Lachenpas*'. The tourism is the primary activity of Lachen people followed by government services and contracts. The topography prevents Lachen from agriculture practices. The use of firewood along with LPG is prevalent in every household due to reasons like cold climate, food habit, proximate and availability of firewood. The entire household in Lachen is '*puccha*' type where the wood-made house structure is common to counter harsh cold climate. There is no such dearth of LPG supply as it is in regular basis despite long distance and rough terrain (road). This is due

¹¹ The traditional local self-government system which is practiced in Lachen and Lachung villages of North Sikkim.

¹² Head of the Dzumsa system.

to good governance that '*dzumsa*' provides to people. There is monthly arrival of LPG cylinder where people in advance informed about it. However, sometimes landslide can cause disruption in road connectivity, so to supply of LPG.

3.3.2. Shipgyer:

Shipgyar is located in Dzongu area (North district) – a restricted area for other than the indigenous inhabitants of the area. It is 25 km away from district headquarter Mangan. The whole Dzongu area is considered as the origin or home of indigenous Lepcha people. Therefore, the whole Shipgyer village is inhabitant by '*Lepcha*' people- indigenous tribal people. They mostly engaged in agriculture and allied activities for their sustenance. They live a simple life which is closely associated with environment/nature. They are very simple and religious people. The government of Sikkim has provided various initiatives to them considering the indignity, socio-cultural and their association with nature/environment. They are provided various government initiatives like free LPG distribution and free electricity among others. Therefore, despite remote location and their engagement in agricultural activities there is good number of household who has LPG connection. But, even after LPG facilities, they considerably depend on firewood use because of their livelihood and socio-cultural practices. There is no LPG delivery system; road and transport system is poor; and so, they have to depend on firewood for fuel security despite having LPG connection. The cost of refill is also high due to transportation and other hidden cost which is discouraging for them as most of them are not so well-off financially.

3.3.3. Namok:

Namok is located nearby Mangan (District headquarter) of North district. It is 5 km away from Mangan and has well connected road connection. It is characterized by undulating topography with rural nature. Namok is dependent on Mangan for the supply of essential commodities like LPG, rice, kerosene etc. Namok is composed of various ethnic communities where '*Lepcha*', '*Tamang*' and '*Subba*' are majority in numbers among others. Most of them are engaged in agriculture and allied activities. It is also observed that some of the inhabitants are from outside Sikkim especially from Darjeeling-Nepal who has settled long back ago engaging themselves in agricultural activities.

In terms of cooking fuel use, majority people are using LPG along with firewood. This is due to close proximity to district headquarter Mangan where the availability of LPG facilities is not a big concern. The firewood use is especially for fodder cooking purpose for livestock. There is no use of kerosene as cooking fuels. There is monthly distribution system but with no fixed timing of delivery which annoys people. In case of emergency refill of cylinder, people tend to go Mangan for its refill which takes time and manpower.

4. West District

3.4.1. Gerethang:

Gerethang is located in West District of Sikkim, approximately 41 km from Gyalsing. It has mild climatic condition i.e. not so cold or hot where maximum temperature reaches 28-29 degree Celsius. It is inhabited by 'Bhutia', 'Limboo', 'Chettri', 'Bhahun' community and majority of them are engaged in primary activities for their sustenance. It is observed that most of the people have access to LPG and less dependence on forest for firewood. Even though there is monthly LPG refill system from Indian Oils, there is no specific date or day of the arrival of LPG refill vehicle. In general, people expect fixed, timely and regular refill distribution system along with the organization of awareness camp like 'connection camp' from concern authorities. Although the frequency of power is regular there is no popular use of cooking devices induction. However, there is popular use of other electronic devices like rice cooker, water boiler etc. The Government of Sikkim through its social program '*Janta Mela*'¹³ has distributed LPG connection to BPL family.

3.4.2. Chakung:

Chakung is located 7 km away from Soreng sub-division. Chakung is a small market area which is well connected with transport services. Therefore, people of this area do not much dependent on other urban areas for basic amenities. However, for services like LPG distribution, people of Chakung have to depend on its nearby sub-division i.e Soreng. There is monthly LPG distribution system but with no definite or fixed timing. Therefore, people need to prepare for anytime for its delivery and have to keep all the necessary documents, money ready for the availability of LPG. In case of emergency, they have to take cylinder to Soreng for filling which require whole day time. Despite having rural in nature, it has urban

¹³ a public function where social schemes are distributes to public especially to BPL families.

character in its outlook having available all the urban stuffs. Majority of people are dependent on agriculture and allied activities. In social composition, Chakung is mostly dominated by '*Gurung*' and '*Rai*'. It is located at high altitude and its climatic condition is characterized by cold climate with considerable rainfall and low temperature throughout the year. There is considerable use of LPG as cooking fuel along with the firewood because of the nature of household's engagement in livelihood and climatic, social cultural characteristics. In other words, the people of Chakung are mostly using mixed type (LPG and firewood) as cooking fuel. In addition, the government's scheme of free distribution of LPG to BPL has played an important role in high use of LPG in this area.

3.4.3. Karthok:

Karthok is a small village, falls under West district which is located 10 km away from its sub-division Soreng. It is mostly inhabited by '*Subba (Limbu)*', '*Chettri*', '*Bahun*'. Their main occupation is agriculture but there is definite sign of shift to others non-agricultural services. The people of Karthok have to dependent nearby Soreng and Jhorethang for their urban needs or basic amenities. Karthok is well connected with '*pucca*' road. The villagers are dependent on firewood and LPG both for cooking fuel. It is because of reasons like agriculture practice, livestock domestication, fuel security, social-cultural practices etc. The people of Karthok depend on Soreng for LPG supply. There is monthly distribution system but there is no fixed time of delivery. In case of urgent need of LPG cylinder, they need to take cylinder to Soreng for its refill which takes whole day. There are some beneficiaries of the Government of Sikkim's LPG distribution system.

3.4.4. Barnyak (Bermek):

It is located approximately 30 km away from sub-division Soreng, West district. It is well connected with road service. It has its own small market (bazaar), so they do not need to travel to far urban areas for basic urban amenities. But, they depend on Soreng for LPG supply with monthly distribution frequency. Therefore, for alternative use of firewood they depend on firewood as well which makes them to depend on more than two cooking fuel. In addition, their engagement in the agriculture, livestock/ socio-cultural practices makes them use firewood. The dominant communities are '*Subba*', '*Chettri*' and '*Bahun*' who are mostly

engage in agricultural practices. There are some beneficiaries of the Government of Sikkim's LPG distribution system to BPL families.

3.4.4. Mabong:

Mabong is located 13 km away from Soreng – sub division of West Sikkim. It is remote as compared to other study villages and mostly dependent on agriculture for their sustenance. Although the availability of road is there but the regular transport service is difficult. People need to prepare themselves in advance to travel to the urban area. Most of the transport facilities run only in the morning and the evening, so people have to prepare themselves for such system.

As far as household cooking fuel is concern, most of the people are dependent on firewood mainly because of fuel security reasons because there is no fixed timing of LPG delivery system despite having LPG connection. Therefore, people tend to depend on firewood despite having LPG connection because of poor LPG distribution system and their engagement in the nature of work for livelihood and socio-cultural practices as tribal people are in majority. In addition, it is observed that the hidden cost to refill is high, they have to spend at least one day's time to get refilled LPG cylinder. In addition to time, shortage of manpower is important issue to short in village areas as they have to full time to get refilled LPG cylinder.

4. Household cooking fuel use in rural Sikkim:

The total sample size from fourteen villages is six hundred (600) from four districts. East district has 100 samples, North district and South district has 150 samples each and West district has 200 samples. Under East district, three villages were selected viz, Assam Lingchey, Pacheykhani and Subaneydara. Here, the household cooking fuels are categorized into three categories viz. 'LPG only', 'firewood only' and 'mixed' (both LPG and firewood use) because these are the prominent fuels use in Sikkim.

Table 4.3: Household cooking fuel in Sikkim (household in numbers)

Districts (sample)	Village	Primary source of fuel for cooking			Total
		Firewood only	LPG only	Mixed (LPG & firewood)	
East District (100)	Assam Lingchey	1	25	18	44
	Pacheykhani	0	4	15	19
	Subaneydara	31	0	6	37
North District (150)	Namok	5	8	17	30
	Shipgyer	18	0	30	48
	Lachen	0	9	63	72
West District (200)	Gerethang	0	8	24	32
	Chakung	9	4	38	51
	Barnyak	17	11	39	67
	Mabong	9	0	22	31
	Karthok	2	4	13	19
South District (150)	Rong	15	5	30	50
	Chuba	36	2	17	55
	Bermiok	4	21	20	45
Total		147 (24.5%)	101 (16.8%)	352 (58.7%)	600

Source: Field survey.

It is observed from the table 4.3 that Assam Lingchey has the highest number of ‘LPG only’ user not only in East district but in the entire sample villages. On the other hand, Subaneydara village has zero household which is dependent on ‘LPG only’ whereas majority (31) of households is dependent on ‘firewood only’ for fuel. In North district, among three viz, Namok, Shipgyer and Lachen, Shipgyer village has the highest number of household that are dependent on ‘firewood only’ whereas there is no single household which is dependent on ‘LPG only’ for fuel. On the other hand, majority (63) of household in Lachen are dependent on mixed fuel i.e LPG and firewood. In West district five villages were selected as survey area viz, Gerethang, Chakung, Barnyak, Mabong and Karthok. Among these villages, Barnyak has the high number of household which are dependent in all the type of fuel i.e. firewood (17), LPG (11) and mixed (39). It is observed from the table 4.3 that Gerethang and Mabong have no household that are exclusively dependent on ‘firewood only’ and ‘LPG only’ respectively. In South district, three villages are selected as survey area; they are Rong, Chuba and Bermiok. Among them Rong and Chuba have high number of household that are

exclusively dependent on 'firewood only' as cooking fuel and only few households are dependent on LPG. However, Bermiok village has high number of 'LPG only' user as compared to other villages.

Overall, among three categories of fuels, the majority of villages are dependent or using more than one fuel for cooking purposes i.e mixed fuel. In total, 352 (58.7%) household are mixed fuel user and 147 (24.5%) and 101 (16.8%) households are sole firewood and LPG users respectively. In terms of clean fuel use i.e LPG, East district has better picture than rest of the districts whereas South district is poor and the dependent on unclean fuel i.e firewood use is high. The high urban population may be the reason behind high LPG user in East district.

5. Socio-economic and demographic profile of the study area (rural Sikkim):

The socio-economic and demographic attributes have central role in the field of social science research. The socio-economic and demographic variables are crucial in the study of regional development. In diverse countries like India, the level of social development is detrimental factor in regionalization. Therefore, to understand the dynamic of developmental aspect, it is imperative to study the socio-economic and demographic aspect in detail. In other words, the level of socio-economic and demographic characteristics of any place or region is directly related to the development.

In this context, it is necessary to understand the socio-economic and demographic characteristics of study area i.e of Sikkim to make synthesis of research output. Therefore, some of the socio-economic and demographic characteristics like religion, social category, house type, family type, household size, household income, nature of work, animal owned, land type, road accessibility and household banking have analyzed to depict the background picture of study area. A study by Lewis and Pattanayak (2012) has also reveal these factors and its role in fuel choice.

Table 4.4: Socio-economic and demographic profile of study area (in percent)

Characteristic		Percent
HH religion	Hindu	33.8
	Buddhism	51
	Christianity	3.8
	Animism	11.4
	Total	100
HH social group	ST	49
	SC	2.2
	OBC	48
	Others	0.8
	Total	100
Age of HH head	Below 40	34
	41-50	35
	Above 51	31
	Total	100
Sex of the HH head	Male	86
	Female	14
	Total	100
Education level of HH	Illiterate	23
	Primary/below primary	38.5
	Secondary	32.8
	Higher education	5.7
	Total	100
Family type	Nuclear	51.8
	Joint	16.7
	Extended	29.5
	Single	2
	Total	100
House type	Pucca	79.8
	Semi-pucca	14.5
	Kuchha	5.7
	Total	100
Ownership of house	Owned	88.7
	Rented	3.3
	Other	8
	Total	100
House accessible by road	Pucca road	20
	Kachha road	10.2

	Footpath	69.8
	Total	100
HH electricity	Yes	100
	No	0
	Total	100
HH size	1-3	14.2
	4-6	82.7
	7 +	3.2
	Total	100
Number of room	1-3	63.8
	4-5	24.2
	6-8	12
	Total	100
Main source of HH income	Agriculture	46.7
	Govt/pension	38
	Private/self/contract	15.3
	Total	100
Nature of work	Agriculture	49.83
	Non-agriculture	50.17
	Total	100
Cultivated land (last year)	Yes	70.2
	No	29.8
	Total	100
Owns Livestock	Yes	80.7
	No	19.3
	Total	100
HH banking	Yes	82.8
	No	17.2
	Total	100
BPL household	Yes	67.2
	No	32.8
	Total	100
Sikkim subject/COI	Yes	84.8
	No	15.2
	Total	100

Source: Field survey.

Historically, Sikkim was occupied by '*Lepcha*' people - they are considered as the original inhabitants of Sikkim. Even there are various schools of thoughts regarding the original people of Sikkim but still, '*Lepchas*' are considered as the original one. They along with '*Bhutia*' community used to coexist in early period in Sikkim. These people are now mostly

follows Buddhist religion. In early period, the '*Lepcha*' people used to practice their own religion i.e animism but later majority of them adopted Buddhism as their religion.

In later period, the demographic characters and population changed due to geo-political factors, particularly influenced by the geopolitical scenario of neighboring areas. At that time, the neighboring countries like Nepal and India and their geo-political and economic interests lead to the sharp demographic change in Sikkim which results the inflow of people (particularly Nepali) from surrounding areas. The purpose of migration of people in Sikkim was mainly induced by the labor shortage in the Kingdom of Sikkim at that period. So, Nepali people started to come in Sikkim as laborer in construction of roads, in the field of agriculture by clearing dense forests and also due to trade relation of India with Lhasa (present day Tibet). Therefore, in the history of Sikkim, the migration of Nepali people marked the major development in Sikkim because it considerably changed the demographic composition of Sikkim. In present day Sikkim, the Nepali people composed of 70% (approximately) of population in Sikkim whereas '*Lepcha*'-'*Bhutia*' population and others composed of 30% (approximately). The majority of Nepali population follows Hinduism as their religion, therefore, making Hinduism as the major religion in Sikkim followed by Buddhism.

In study area, it is observed that most of the households follow Buddhist religion constituting (51%), followed by Hindu religion (33.83%), '*animisim*'/'*yumanism*' (11.33%) and Christianity (3.83%). Besides the '*Lepcha*'-'*Bhutia*' communities, other communities like '*Gurung*', '*Tamang*' also follows Buddhism. Within Nepali community, Kiratis communities like '*Subba*' (*Limbu*), '*Rai*' and some '*Lepcha*' communities practiced '*animisim*'/'*yumanism*' (worshipper of local god or goodness related to nature) as their religion. However, the percentage of Christianity is less as compared to others and it is mostly concentrated in urban areas of Sikkim.

It is observed in table 4.4 that most of the people are from '*Scheduled Tribe (ST)*' and '*Other Backward Class (OBC)*' social category. The percentage of ST is 49%, followed by OBC (48%), Scheduled Caste (SC) 2.17% and '*Others*' (0.83). The state of Sikkim has two types of OBC categories i.e OBC Central List and OBC State List and there is no general category in Sikkim.

The '*age of the household*' and '*sex of the household*' are important factors in the analysis in the social science research. Here, the age of the household is categorized into three categories viz., '*below 40*', '*41-50*' and '*above 51*'. There is not so much variation in terms of percentage variation among these categories. These three categories constitute 34%, 35% and 31% respectively with slightly higher percentage in '*41-50*' category. It indicates that the majority of household in rural Sikkim headed by young age which may be the reason for high percentage of mixed fuel use. Likewise, in '*sex of the household*', it is observed that '*male*' headed household is substantially high in the rural Sikkim constituting 86%. In contrary, '*female headed household*' constitute only 14% which indicated that the gender disparity exists when it comes to regulating household activities. The low female headed household shows that the practice of patriarchy is practiced in rural Sikkim even if not directly. Although, there may be some household where male is absent due to natural cause but this is not solely because of the natural cause life dead of male counterpart; migration, divorce may be other reason etc.

The education level is one of the important determinants in social science research. It is considered a powerful factor which influences the socio-economic development. It considered the driver of social change. At household analysis, the education household head of important because they take and make important household decisions which directly affect their conditions. Here, '*education level of household head*' is categorized into four categories viz., '*illiterate*', '*primary/below primary*', '*secondary*' and '*higher education*' which constitute 23%, 38.5%, 32.8 % and 5.7% respectively. Overall, the percentage of '*illiterate*' is low as compared to literate and majority of household heads have the education level of '*primary/below primary*' and '*secondary*'. However, the percentage of '*higher education*' among household head is meager.

In terms of family type, most the family is '*nuclear*' type. This picture clearly depicts from the survey sample where it is found that 51.83% of household are '*nuclear*', followed by '*extended*' (29.5%), '*joint*' (16.67%) and '*single*' (2%). It came to know from the respondents that '*out-migration*', '*nature of job*' and '*marriage*' have been the major reasons behind the maximum number of '*nuclear*' family in rural areas along with the young generations' preference for the '*nuclear*' family. In addition, it is also found that people who

are engaged in non-agriculture activities are under '*nuclear*' family type. Therefore, it can be said that the new generations who are engaged in non-agriculture activities have been opting for '*nuclear*' family. In contrary, '*extended*' family mostly consist of old-aged people like parents and grandparents who all are living with their not so young children and their spouse. The percentage of '*single*' family is very negligible in study area. It is found that only 2% household is '*single*' family type.

In terms of type of house, Sikkim has done tremendously well in constructing '*pucca*' house. The achievement of high percentage of '*pucca*' house is mainly due to the initiatives of the Government of Sikkim (GoS). The GoS has been providing free '*pucca*' housing to the Below Poverty Line (BPL) families over the years. The GoS has been providing all the construction materials like cement, tin (*chyadar*), rod etc to build the '*pucca*' house to the BPL families. Now, the GoS aimed to become '*kuchha*' house free by 2020. The percentage of '*pucca*' house in the surveyed area is 79.83% where '*kuchha*' house constitute only 5.67% and '*semi-pucca*' constitute 14.5%. Therefore, majority of population are living in '*pucca*' house even in rural areas due to the noble scheme of the GoS. Likewise, the ownership of house is categorized into '*owned*', '*rented*', and '*other*'. It is observed that majority of house (88.7%) is '*owned*' whereas '*rented*' and '*other*' category constitute 3.3% and 8%. The '*other*' category includes those household which resides in or with house of the landlords as cultivators.

The accessibility of road in rural areas is very challenging issues especially in hilly terrain region. In the field survey, it is considered that if the house is located within the 50 m from road side then it is considered as accessible by road, otherwise it is not. So, keeping this criterion, the accessibility of road is measured in survey villages. On the basis of this criterion, it is found that only 20% of rural house in survey villages is access to '*pucca*' road whereas 69.83% of house is access by '*footpath*'. However, it is observed that only 10.17% is constituted by '*kuchha*' road. It is mainly because Sikkim has high percentage of '*pucca*' road than '*kuchha*' road. Even at village level, most of the roads constructions are '*pucca*' road and majority of road are constructed under the centrally sponsored scheme i.e. The

“Pradhan Mantri Gram Sadak Yojana (PMGSY)”¹⁴. The condition of *‘footpath’* is also good and majority of houses have access to *‘footpath’*. In most of the surveyed villages, it is found that ‘the construction of ‘footpath’ is carried by “Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)”¹⁵. In terms of access to electricity, there is excellent coverage in rural area. It is observed that 100% of household have access to electricity connection.

Over the years, the *‘family size’* in Sikkim has been getting smaller even in rural areas and younger generation is opting for the small family. This may be due to the awareness about family planning and economic burden or nature of work of larger family size. Here, the household size is classified into three: *‘1-3’*, *‘4-6’* and *‘7+’*. It is observed that majority of household have size of *‘4-6’* constituting 82.7%, followed by *‘1-3’* (14.2%) and *‘7+’* (3.2%). The low percentage of *‘7+’* family (3.2%) further supports the trend of adaptation of small family size over the years. As mentioned earlier, most of the family type in rural Sikkim is *‘nuclear family’*, which means on an average nuclear family size constitute in the range of *‘4-6’* members. Similarly, number of room has categorized into three groups: *‘1-3’*, *‘4-5’* and *‘6-8’* where it is observed that majority of household has *‘1-3’* rooms constituting 63.8% followed by *‘4-5’* (24.2%) and *‘6-8’* (12%) respectively.

Sikkim, being a landlocked and Himalayan state, there are limited employment opportunities leaving the government service and agriculture are two major options. The agriculture sector is not in large scale due to topography resulting small and fragmented type of agriculture practice. Therefore, agriculture and government service are the major source of income in Sikkim. In recent years only, the percentage of people are engaged in private services are going up due to inflow of some private stakeholders in Sikkim where mostly young generation tend to engage. The percentage of people who are engaged in full time agriculture activities are decreasing especially in young generation. It is observed that even in rural areas, the young generation tends to opt for other activities rather than in agriculture. Therefore, old generations are the people who are still engaging themselves in agriculture

¹⁴ The Pradhan Mantri Gram Sadak Yojana (PMGSY), was launched by the Govt. of India to provide connectivity to unconnected Habitations as part of a poverty reduction strategy.

¹⁵ MGNREGA is an Indian labour law and social security measure that aims to guarantee the 'right to work'. It aims to enhance livelihood security in rural areas by providing at least 100 days of wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work.

activities in rural areas. It is observed that 46.67% of population is engaged in 'agriculture' activities for their source of income whereas 38% are dependent on 'government' for their source of income even in rural areas. The percentage of 'private/self/contract' as the source of income is 15.33% which is tend to go up because most of the people are opting self-employed scheme due to high unemployment in the state. However, there is no such variation in terms nature of work. It is observed that 'agriculture' and 'non-agriculture' nature of work constitute 49.83% and 50.17% respectively. The 'non-agriculture' activities include the self employed, private service, contractors, government employees etc. So, including all these aspects, engagement in non-agriculture work is slightly higher than agriculture even in rural areas of Sikkim. It is primarily due to the process of rural development and incoming of various international, central and state projects in the villages. It also shows that the shift of agriculture society to non-agriculture society which implies that people in rural areas are tend to engage more in non-agriculture works that than traditional agriculture system. In terms of cultivation of land in last year, it is reported that 70.2% of household cultivated land and 29.8% did not cultivate any land. Although the majority of household cultivated land but it is reported that agriculture is not the main source of income. The people in rural areas tend to engage in cultivation as leisure despite having other source of income like government service or pension or private services etc.

In recent years, the nature of work has been changing in Sikkimese society. The transformation from typical rural based society to more leaning towards the urban centric society has been taking place. The difference in the way of life between so called rural areas and urban areas is minimal as most of the amenities of urban areas are available in rural areas as well. This is primarily because of the small geographical area of state due to which one part of the state to other extreme can be travel within maximum hour of five hours state. Therefore, there is not so variation in rural and urban life.

When it comes to domestication of livestock, majority of people are owns one or more than one livestock in the house. From the survey data, it is found that 80.67% of rural household 'own livestock' and only 19.33% of house does not 'own livestock'. It implies that even if people engage in non-agricultural activities, they still domesticate some form of livestock which serves dual purpose viz., income and supply of manure for vegetables.

Now a day, banking sector has been the important and basic service that is required by all in anywhere. In this aspect, the rural areas of Sikkim has done considerably well in accessing banking service. It is found from the surveyed villages that 82.83% of household have any kind of banking service. On the other hand, there are only 17.17% of household that do not have banking service. One of the main reasons of high banking coverage in Sikkim even in rural areas is because of the GoS's own banking service i.e "State Bank of Sikkim (SBS)" which is functional within the jurisdiction of Sikkim. The high percentage of banking coverage is good implication due to the recent surge in the digital transaction and some of the government schemes are distributes trough the digital transaction unlike hard transaction in early days. For instance, the LPG subsidy is systematically link with the banking system so that subsidiary amount directly goes to bank account holder of entitled individuals, so there is limited chance of leakage of subsidized money or role of middle man is limited. The percentage of household under "*Below Poverty Line (BPL)*" is 67.2% and "*Above Poverty Line (APL)*" constitutes 32.8% in study area. Likewise, the percentage of household who have "*Sikkim Subject/Certificate of Identification (COI)*" is 84.8% and 15.2% do not have. These documents are important is accessing social schemes in Sikkim. All these mention factors have influential role in various fuel choice.

6. Household characteristics associated with fuel use:

The total survey area has observed hundred percent of electrification. The primary source of lightening is electricity in the entire surveyed household which highlights the 100% access to electricity. It may due to the government's schemes like the "Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY; previously Rajiv Gandhi Grameen Vidyutikaran Yojana - RGGVY)"¹⁶, Saubhagya¹⁷ and "Ujjwal DISCOM Assurance Yojana (UDAY)"¹⁸. However, the reliability supply of electricity needs to improve. The provision of manpower to repair at the time of frequent power cut is highly needed.

¹⁶ Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) is a Government of India scheme designed to provide continuous power supply to rural India.

¹⁷ The Saubhagya Scheme or Pradhan Mantri Sahaj Bijli Har Ghar Yojana is an Indian government project to provide electricity to all households.

¹⁸ Ujjwal DISCOM Assurance Yojana (UDAY) is the financial turnaround and revival package for electricity distribution companies of India (DISCOMs) initiated by the Government of India with the intent to find a permanent solution to the financial mess that the power distribution is in.

Table 4.5: Basic household characteristic and fuel use

	Characteristic	Percent
Primary source of lightning	Electricity	100
	Total	100
Primary source of cooking fuel	Firewood	24.5
	LPG	16.8
	Mixed (LPG & firewood)	58.7
	Total	100
Household cooking fuel use	HH consumes only solid fuel	24.5
	HH consumes both solid and non-solid fuel	58.7
	HH consumes only non-solid fuel	16.8
	Total	100
Household non-food fuel use	Same for both food and non-food items	42.7
	Different for food and non food items	57.3
	Total	100
Oven use for cooking food	Traditional chullah	42
	Improved chullah	41.2
	Gas stove	16.8
	Total	100
Place of cooking	Has separate kitchen	88.2
	Doesn't have separate kitchen	11.8
	Total	100
Kitchen have improved chimney	Yes	80.7
	No	19.3
	Total	100
Window or vent in cooking room	Yes	89.7
	No	10.3
	Total	100
Type of fire stove among firewood user	Chullah under a chimney	69.5
	Chullah not under chimney	13.7
	LPG only	16.8
	Total	100
Household decision on cooking fuel	Wife	90
	Husband	10
	Total	100
Who usually cooks	Women	81.7
	Men	2.7
	Both	15.7
	Total	100
Education level who cooks	Illiterate	29.7
	Primary/below primary	34.2

	Secondary/below secondary	31.3
	Higher education	4.8
	Total	100
Education level of decision maker on cooking fuel	Illiterate	25.3
	Primary/below primary	31.5
	Secondary/below secondary	37
	Higher education	6.2
	Total	100
Aware about the uses of LPG/Induction cooking system	Yes	99.2
	No	0.8
	Total	100
LPG distribution system	Weekly	8.2
	Once in a month	36.3
	Do not have fixed time	25
	Do not have distribution system	30.5
	Total	100
LPG frequency	Regular	24
	Irregular	76
	Total	100

Source: Field survey.

In terms of primary cooking fuels, Sikkim is exclusively dependent on three types of cooking fuels viz., ‘firewood’, ‘LPG only’ and ‘mixed’ (firewood and LPG). The use of other cooking fuels like kerosene, charcoal, electricity; compressed natural gas (CNG), biogas etc are minimal or completely absent. It is observed that majority of household are dependent on ‘mixed’ type of cooking fuel i.e. both firewood and LPG which constitute 58.7%, followed by firewood (24.5%) and LPG (16.8%). It implies the issues like fuel security, irregular provision of clean cooking mechanism in rural areas. In addition, it may also due to engagement of agricultural and livelihood practices and cultural practices which compels people to depend on firewood along with the LPG. The question of availability, accessibility and affordability of various cooking fuels also comes in rural Sikkim. Likewise, the same picture reveals in ‘household cooking fuel use’ category viz. ‘household consumes only solid fuel’ (24.5%), ‘household consumes both solid and non-solid fuel’ (58.7%) and ‘household consumes only non-solid fuel’ (16.8%).

The consumption of fuels also varies in food and non-food items. For instance, fuel consumption in cooking food and non-food items like fodder, heating varies. In this aspect,

the household using same fuel use for both food and non-food items constitute 42.7% and those using different fuel for food and non- food items constitute the 57.3%. The household using same fuel use for both food and non-food items constitute 42.7% either totally dependent on firewood or LPG. On the other hand, those household using different for food and non- food items constitute the 57.3% reveals that they are using more than one fuel for food and non-food consumption. The higher the percentage of different fuel for food and non- food items explains the livelihood (agricultural and cultural practices) and cold climatic condition which are forcing rural household to depend on more than one fuel. In terms of oven use, 'gas stove' constitute 16.8% and 'improved chullah' (41.2%) and the household who are dependent on 'traditional chullah' constitute 42%.

It is observed that 88.2% household has a 'separate kitchen' which is a good indicator leaving 11.80% household which 'doesn't have a separate kitchen'. Likewise, the household having 'improved chimney' in village constitute 80.7% while those household that 'do not have' constitute 19.3%. Similar in the case of household having window or vent in cooking room. It is observed that 89.7% household has 'window or vent' and only 10.3% household that don't have. In addition, it is noticed that 69.5% of household which uses firewood have 'chullah under a chimney' and those household that does not have 'not under chimney' constitute 13.7% and the rest 16.8% is 'LPG only' user. Having 'separate kitchen', 'improved chimney', 'window or vent in kitchen' along with 'chullah under chimney' has major implications on health. This is a positive outlook that even the rural areas of Sikkim have such level of household characteristics. It has direct health implication especially on women and children as they are more prone to indoor air pollution caused by use of biomass fuels like firewood (WHO 2007).

The decision on choice of fuel hood has its own implication. It is argued that in a household, women/wife usually makes decision on cooking fuels as they are the one who tend to bear the burden of cooking in house. Therefore, the gender aspect has come to play while making decisions on cooking fuels. It is observed that the 90.0% of the decisions on cooking fuels is taken by the wife/women while only 10% by husband/men. From the gender prospective, it is considered that the women tend to take logical decision on resource management as they are the ones who are in constant engagement in natural resource utilization (firewood, water etc)

process as compared to their male counterpart, so for the cooking fuels (Agarwal 2000). Therefore, it is a good sign that more women participation in the decision making process, directly or indirectly in the environment management process. Women tend to engage more in kitchen activities like cooking food. It is observed from the study area that 81.7% of cooking in household is done by women as compared to 2.7% by men. The figure for both men and women who cooks stands 15.7%. These figure reveals that the gender differential exists in the household activities in kitchen activities especially in cooking purpose. It may be due the existence of old age tradition practice of agriculture which requires masculinity for outdoor activities which suits for men which are not required for household activities like cooking among others. In addition, the level of education of those who cooks is also equally important in decision making. It is noticed the education level of those who cooks viz., 'illiterate' (29.7%), 'primary/below primary' (34.2%), 'secondary/below secondary' (31.3%), and 'higher education' (4.8%). Likewise, the education level of decision maker on cooking fuel is also important. In this aspect, data shows similar trend like those who cooks viz., 'illiterate' (25.3%), 'primary/below primary' (31.5%), 'secondary/below secondary' (37.0%) and 'higher education' (6.2%). The available literature shows, higher the education level there will be a positive chance of clean cooking fuel use. Therefore, the role of education has important role to play in the environment management system. The education brings other aspects like awareness which is very essential. In terms of awareness about the modern cooking fuels like LPG/induction, the data shows positive results with 99.2% respondents are aware, only 0.8% is unaware about the LPG/induction.

To make LPG accessible for all rural areas, it is essential to have good distribution system. It is observed from the study area that LPG distribution system is poor, for instance, 'weekly' (8.2%), 'once in a month' (36.3%), 'do not have fixed time' (25.0%), 'do not have distribution system' (30.5%). Similarly, the LPG frequency is also poor with only 24.0% of household responded regular. On the other hand, majority of household i.e 76.0% responded irregular in LPG distribution frequency. It can be said that the LPG distribution system and its delivery frequency in rural Sikkim is poor which needs to be strengthen to make LPG available, accessible and affordable for all.

7. Primary source of fuel for cooking

The socio-economic variables like income have always a significant effect on uptake of clean cooking fuels whereas households having below poverty line card, family size, size of farm land, and reserved social groups like SC/ST have a significant negative association (Pandey & Chaubal 2011). As per Lewis and Pattanayak (2012), the other socioeconomic determinants of fuel and stove choice are income, education, household size, location, religion, social groups, credit access, and fuel prices (also see Mekonnen & Kohlin, 2009; Rao & Reddy 2006). The adoption of improved cooking stoves and clean fuels choice are directly associated with income and education (head of household and female) whereas socially marginalized status SC/ST are indirectly associated. Several studies also expose that apart from income there is a high and positive correlation between using clean fuel with women empowerment, education, sex of the head of household and accessed to electricity. The fuel switching from biomass fuel to cleaner fuel will enhance for households with female head, access to electricity and higher female education, however, worse for male education and households working in agricultural and casual labor. Better off households (Behera Dash & Yadav 1991; Duflo et al 2008; Kishore & Spears (2012)) and the households resides in urban areas (Lewis and Pattanayak 2012) are more likely to use cleaner stove that use clean fuel.

The table 4.6, depicts the type of household cooking fuels use across various socio-economic and demographic factors in the study area (rural Sikkim). It is mentioned earlier that the socio-economic and demographic factors are very important which influence the development process. Likewise, the various household cooking fuels use also varies as per socio-economic and demographic aspects. Generally, the higher socio-economic level tends to effect positively in the use of cleaner fuel. For instance, the higher socio-economic level higher will be the use of clean fuel use like LPG and lower the socio-economic level people tend to depend on lower quality or traditional fuels like firewood or coals etc. This phenomenon is precisely demonstrated by the “ladder model” which states that higher the income of household, there will be higher chances of use of cleaner fuel in cooking. On the other hand, lower the income; there will be higher chances of use of low quality cooking fuels. In this ladder model, use of firewood, charcoal, cow dung as cooking fuel constitute the lower ladder whereas the fuels like LPG, electricity, bio fuels constitute the higher ladder.

Table 4.6: Primary source of fuel for cooking across socio-economic-demographic and environment profile (in percent)

		Primary source of fuel for cooking			
		Firewood only	LPG only	Mixed (LPG & firewood)	Chi square
District	East	32	29	39	52.625***
	North	15.3	11.3	73.4	
	West	18.5	13.5	68	
	South	36.7	18.7	44.7	
	Total	24.5	16.8	58.7	
Religion	Hindu	20.7	26.1	53.2	77.830***
	Buddhism	28.1	7.8	64.1	
	Christianity	13	69.6	17.4	
	Animism	23.5	11.8	64.7	
	Total	24.5	16.8	58.7	
Social Category	ST	20.4	10.9	68.7	34.609***
	SC	23.1	38.5	38.5	
	OBC	29.2	21.2	49.7	
	Others	0	60	40	
	Total	24.5	16.8	58.7	
Family Type	Nuclear	23.8	25.1	51.1	34.881***
	Joint	25	10	65	
	Extended	24.3	7.3	68.4	
	Single	41.7	0	58.3	
	Total	24.5	16.8	58.7	
Family size	1-3	17.6	35.3	47.1	25.703***
	4-6	26	13.9	60.1	
	7 +	15.8	10.5	73.7	
	Total	24.5	16.8	58.7	
Age of HH head	Below 40	22.5	28.4	49	44.641***
	41-50	27.6	16.7	55.7	
	Above 51	23.1	4.3	72.6	
	Total	24.5	16.8	58.7	
Sex of the household head	Male	25.6	15.9	58.5	3.714***
	Female	17.9	22.6	59.5	
	Total	24.5	16.8	58.7	
Education of the household head	Illiterate	39.9	2.2	58	160.899***
	Primary/below primary	32.9	7.4	59.7	
	Secondary	8.1	28.9	62.9	
	Higher education	0	70.6	29.4	

	Total	24.5	16.8	58.7	
House Type	Pucca	16.5	20.9	62.6	103.688***
	semi-pucca	48.3	0	51.7	
	kuchha	76.5	2.9	20.6	
	Total	24.5	16.8	58.7	
Numbers of room	1-3	30.5	17	52.5	28.030***
	4-5	12.4	13.1	74.5	
	6-8	16.7	23.6	59.7	
	Total	24.5	16.8	58.7	
Main source of HH income	Agriculture	51.1	1.1	47.1	239.767***
	Govt service/pension	0.9	29.8	69.3	
	Private/self employed/contract	2.2	32.6	65.2	
	Total	24.5	16.8	58.7	
House accessibility by road	Pucca	0	47.5	52.5	157.450***
	Kuchha	3.3	3.3	93.4	
	Footpath	34.6	10	55.4	
	Total	24.5	16.8	58.7	
Distance to travel to get LPG	1km/below 1km	10	24	66	141.555***
	Above 1 km	51.7	3.3	45	
	Total	24.5	16.8	58.7	
Cultivates any land last year	Yes	34.4	1.4	64.2	
	No	1.1	53.1	45.8	263.145***
	Total	24.5	16.8	58.7	
Own livestock	Yes	30	2.9	67.1	35017.8***
	No	1.7	75	23.3	
	Total	24.5	16.8	58.7	
BPL	Yes	36.2	8.7	55.1	120.007***
	No	0.5	33.5	66	
	Total	24.5	16.8	58.7	
Banking	Yes	16.7	19.5	63.8	97.195***
	No	62.1	3.9	34	
	Total	24.5	16.8	58.7	
Sikkim Subject/COI	Yes	16.1	17.5	66.4	131.524***
	No	71.4	13.2	15.4	
	Total	24.5	16.8	58.7	

Source: Field survey.

p-value: ***<0.01, **<0.05 and * <0.1

The table 4.6, shows the type of cooking fuels use among various socio-economic aspects in rural Sikkim (study area). It is observed that the use of firewood as cooking fuel is high in

South district (36.7%), followed by East district (32%), West district (18.5%) and North district (15.3%) respectively with aggregate percentage of state 24.5%. However, in terms of only LPG use as cooking fuel; the East district (29%) with above state average (16.8%) outperforms the other districts. East district is followed by South district (18.7%), followed by West district (13.5%) and North district (11.3%) respectively. In terms of mixed fuel use (both firewood plus LPG), North district performs well with average of 73.3% use which is above state average of 58.7%, followed by West district (68%), South district (44.7%) and East district (39%) respectively. From the state percentage it is observed that the percentage of household who use LPG only is 16.8% which is lower than the households who are dependent on only firewood use (24.5%). The high percentage of mixed fuel use is also attributes to the availability of alternative fuels. In one study by Treiber, Grimsby and Aune (2015) found that availability of fuel is also one of the main determinants of having more than one fuel in stock.

The data is also revealing that percentage use of *'mixed'* fuel type (58.7%) is considerably high than the *'firewood only'* and *'LPG only'* use in all districts. In other words, household in survey area is dependent on more than one type of cooking fuels which is due to the various socio-economic and geo-political factors like agriculture, livestock, cultural practices, fuel security, distance and transportation, irregular distribution system and climate condition among others.

In terms of religion, 28.1% Buddhist household tends to use firewood as cooking fuel which is slightly higher than state average of 24.5% and followed by household who practices *'Animism/Yumanism'* (23.5%), *'Hinduism'* (20.7%) and *'Christianity'* (13%). In terms of *'LPG only'* use, the Christian household significantly leaves other household who follows other religion with 69.6% way above state average of 16.8% followed by *'Hinduism'* (26.1%). The parentage who only use as cooking LPG is considerably low in *'Buddhism'* and *'Animism/Yumanism'* household followers with 7.8% and 11.8% respectively below state average of 16.8%. The table 4.6 again shows that the percentage of household dependent on mixed fuel is high except *'Christianity'* religion. In *'mixed fuel'* use category, household who follows *'Animism/Yumanism'* and *'Buddhism'* have more or less same percentage of 64.7 and 64.1 above the state aggregate 58.7% which is high as compared with household with other

religion groups. The main differences in various cooking fuels viz., firewood, LPG and 'mixed' among religion groups is due to the nature of work and cultural/traditional practices that the household engaged and their way of life. For instance, cultural practices like prayer, livestock rearing, agriculture practices, and food and taste culture greatly influence the household cooking fuel choice. This is evident from the given table 4.6 that the percentage of household dependent on firewood and mixed fuel use is high among '*Buddhism*' and '*Animism/Yumanism*' religious groups whereas same percentage is low against Christian household.

Among the social groups there is not so much variation in firewood use as cooking fuel where OBC household with 29.2% firewood use leads the group which is above state average of 24.5% followed by SC household (23.1%), ST household (20.4) and others (0%). However, there is drastic change in the use of '*LPG only*' as household cooking fuel where '*Other*' household has considerably high percentage (60%), followed by SC (38.5%), OBC (21.2%) and ST (10.9%) where the state average is 16.18%. In '*mixed fuel*' category, ST household with 68.7% has the highest and is the only social group category that is above state percentage of 58.7%. It is observed clearly from the table that ST household has largely dependent on firewood even if they are using LPG. This also explains their way of life and their attachment with nature for their cultural/traditional practices. It is found that majority of tribal people had one or more than one kind of livestock in their house which ultimately forces them to depend on firewood. This argument is further justified by observing the '*LPG only*' use in ST household, which is only 10.9%. However, if we see the '*others*' category there is no household who are dependent on '*firewood only*'. It is because that, there is no such '*other*' category in the state of Sikkim but people who are from outside Sikkim like plainsman who engaged themselves in private services business like shopkeeper, trash picker, bottle picker, renter are considered '*Others*'. And these people do not need firewood because of their nature of work as they do not practice agriculture and do not domesticate livestock. Therefore, dependent on firewood is directly related to the nature of work that household is engaged. For instance, it is inevitable not to depend on firewood if the household engage in agriculture, domesticate animals and practices old aged cultural practices and tradition especially in tribal, communities.

The percentage of household who are dependent on various kind of cooking fuels also varies across family type. The family type of survey areas is categorized into four categories viz, '*nuclear*', '*joint*', '*extended*' and '*single*'. It is evident from the table that '*single*' household is highly dependent on '*firewood only*' (41.7%) and dependent on '*mixed fuel*' is 58.3%. They either fully dependent on '*firewood only*' or they depend on '*mixed fuel*' for cooking purposes. After '*single*' household, '*joint*' family is second in terms of '*firewood only*' use contributing 25%, followed by extended (24.3%) and nuclear (23.8%) with state average of 24.5%. Here also most of the family groups are dependent on '*mixed fuel*' where the percentage of '*extended family*' is high (68.4%), followed by '*joint*' (65%), '*single*' (58.3%) and '*nuclear*' (51.1%). However, if we see the '*LPG only*' as household cooking user then there is wide difference between household type where its observed that the '*nuclear*' family type with 25.1% tops the LPG user toppling state average of 16.8 % followed by '*joint*' (10%) and '*extended*' (7.3%). The percentage of '*mixed fuel*' use in '*extended*' family is justified by the fact that this group of family mostly engaged in some kind of agricultural and livestock practices. So, even if they have access to LPG as cooking fuel, they still dependent on firewood simply because of their nature of work they are engaged. It is observed from the field survey that considerable number of '*nuclear*' families is engaged in non-agricultural activities due to which only LPG user are high in number. Here, also nature of work those households are engaged come out major determining factor in terms of dependence on various household cooking fuels.

The probability of using LPG increases with household size: larger the size higher probability of LPG use. In other words, large households are more likely to use both solid and non-solid fuels (World Bank 2003). A similar result reveals from the study that the larger family size is more dependent on various cooking fuels in case of Sikkim firewood and LPG. It is observed that largerer the family size of '7 +' higher the use of the percentage of '*mixed fuel*' use (73.7%). The family size is categorized into three categories viz., '*1-3*', '*4-6*' and '*7 +*'. In terms of '*firewood only*' use, the family size of '*4-6*' has high percentage (26%) among other family size followed by '*1-3*' (17.6%) and '*7 +*' (15.8%). However, in terms of '*LPG only*', the smaller family size i.e '*1-3*' tends to have high percentage use (35.3%) whereas trend has been decreasing for larger family size i.e higher the family size, lower percentage of LPG use. This point is further justified by the percentage of '*mixed fuel*'. Here, it is observed that,

larger family size tend to depend on '*mixed fuel*' than the smaller family size. It is observed that the larger family size of '7 +' have high percentage of '*mixed fuel*' use (73.7%) and it decreases in the family size of '4-6' (60.1%) and '1-3' (47%) respectively. From the above data, it can be state that the smaller family size tends to depend in clean cooking fuel than the larger family.

In terms of age of the household head, there is no such difference is found in firewood use. Among the tree categories viz, '*below 40*', '*41-50*' and '*above 51*', the percentage use of '*firewood only*' is found high in the group '*41-50*' (27.6%), followed by '*Above 51*' (23.1%) and '*Below 40*' (22.5%). However, there is substantial difference in LPG use among age of the household. It is observed that younger age of the household tend to use more '*LPG only*' than the older household. For instance, '*below 40*' observed 28.4 % of '*LPG only*' use, which follows the decreasing trend in the age group '*41-50*' (16.7%) and '*Above 51*' (4.3%). However, in '*mixed fuel*', the age group of '*Above 51*' years observed high percent (72.6%), followed by decreasing trend in age wise in '*41-50*' (55.7%) and '*Below 40*' (49.0%). The age of the household head figure implies that the younger household head tend to depend more on cleaner fuels like LPG whereas the older household head tend to depend on firewood or '*mixed fuel*' as cooking fuel.

In terms of '*sex of the household head*', it is observed that the '*male*' headed household tends to depend on firewood more that the '*female*' headed household. The data shows that the 25.6% of '*male*' headed household is dependent on '*firewood only*' whereas only 17.9% is for '*female*' headed household. This implies that the '*female*' headed household is more dependent '*LPG only*' as cooking fuel than the male counterpart. It is justified by the percentage of '*LPG only*' use data. It is clearly observed that '*female*' headed household has substantially high percentage of '*LPG only*' use (22.6%) than the '*male*' counterpart (15.9%). The argument is also supported by '*mixed*' (though not wide variation) fuel use where percent is slightly high in '*female*' headed household than '*male*' headed household. This results is similar to the study carried out by Lewis and Pattanayak 2012; Mekonnen & Kohlin, 2009; Rao & Reddy 2006 where they have mentioned that female headed household leads to comparatively high use of clean fuels; other several studies also reveals the same result.

Likewise, the '*education of the household head*' also reveals the similar picture. Among the four categories viz., '*illiterate*', '*primary/below primary*', '*secondary*' and '*higher education*', the trend is negative between firewood use and '*education of the household head*'. In other words, higher the education level of household head lower is the firewood use as cooking fuel. For instance, '*illiterate*' household head observed high percentage of '*firewood only*' use (39.9%) and which starts declining with increasing level of household head i.e. '*primary/below primary*' (32.9%), '*secondary*' (8.1%) and recording zero percentage in '*higher education*'. Contrarily, the percentage of '*LPG only*' use and level of education of household head observed positive relationship. In other words, higher the education level of household head, higher is the percentage of '*LPG only*' use i.e. the percentage of '*LPG only*' for '*illiterate*' (2.2%), '*primary/below primary*' (7.4%), '*secondary*' (28.9%) and '*higher education*' (70.6%). In '*mixed*' category, there is not so much variation among '*illiterate*', '*primary/below primary*', '*secondary*'. However, the percentage of '*mixed*' fuel use is low (29.4%) among the household head with higher level of education. It implies that the use of '*LPG only*' is high among those household head that have higher level of education. The result is similar to the study carried out by Lewis and Pattanayak 2012; Mekonnen & Kohlin, 2009; Rao & Reddy 2006 where they state that the education is one of the important factors in choosing clean fuel. Therefore, the level of education of household head is very crucial in the LPG use. It may be attributed to the awareness as well as the high income generation through higher level of income and also due to the nature of job.

The condition or nature or type of house structure is also important factors which determine the type of cooking fuel use. Generally, the available literature reveals that people who lives in '*kuchha*' house have limited access to clean cooking fuels LPG and they mostly tend to depend on low quality cooking fuels like firewood, biomass or charcoal etc. The same kind of information reveals in data. From the table 30, it is observed that percentage of firewood is less in '*pucca*' house (16.5%) below state average (24.5%) and the use of '*LPG only*' (20.9%) and '*mixed fuel*' (62.6%) is high among all house type. Dependent on only firewood is high in '*kuchha*' house with 76.5% followed by '*semi-pucca*' (48.3%). The percentage of household that use '*LPG only*' as cooking fuel is low in '*semi-pucca*' and '*kuchha*' house because they mostly dependent on '*mixed fuel*' use contributing 51.7% and 20.6%

respectively. With average state figure of 58.7%, the '*mixed fuel*' is dominant in across all house type which indicates that despite access to clean cooking fuel i.e LPG, people still dependent on firewood due to their socio-economic and geo-political reasons.

The number of rooms in a house is categorized into three groups viz., '*1-3*', '*4-5*', and '*6-8*'. It is observed that household having less the number of rooms tends to have high percentage of firewood use than the household having more rooms. For example, '*1-3*' have 30.5% which is followed by other categories. Inversely, the percentage of '*LPG only*' use is high in '*6-8*' rooms (23.6%), and decreases in '*1-3*' (17.0%) and '*4-5*' (13.1%) groups of house room. In '*mixed*' fuel, the '*4-5*' room category observed substantially high percentage (74.5%), followed by '*6-8*' (59.7%) and '*1-3*' (52.5%). It can be generalize that the house having less number of rooms tends to use firewood as cooking fuel slightly higher than the house having more number of rooms. In opposite, the house having more number of rooms tend to use LPG substantially than other house having less rooms. Further, the house having '*4-5*' rooms tend to use more than one cooking fuel. Such disparity in terms of fuel use is mainly because of economic and livelihood practices in rural areas.

The percentage of various household cooking fuels in terms of main source of household income reveals that 51.1% of household from the surveyed area are dependent on '*firewood only*' whose main source of income is agriculture considerably high that state average of 24.5%. Contrarily, this percentage is very low to those household whose main source of income is '*government service/pension*' and '*private/self employed/contract*' contributing 0.9% and 2.2% respectively. Among those household who are engaged in agriculture from their main source of income it is observed that only 1.1% of household is depend on '*LPG only*' and even the '*mixed*' fuel category is less than that of '*firewood only*' use in agricultural household. In '*LPG only*' use category, the household whose main source of income is '*private/self employed/contract*' and '*Government service/pension*' have high percentage of 32.6% and 28.9% respectively. The '*mixed fuel*' category also reveals the same scenario where household having source of income of '*Government service/pension*' and '*private/self employed/contract*' has high of 69.3% and 65.2% respectively higher than state average of 58.7%. Here also '*mixed fuel*' is dominant across all the income groups. This is because of the fact that even the household members are engaged in government service or

private service they tend to engage themselves in certain kind of agricultural and domestication of livestock practice out of their own will which directly leads to the dependent on firewood even the household uses LPG as cooking fuel.

Accessibility of road is an important aspect in the rural area (infrastructure). It is like a blood vessel which supplies basic facilities or social services/schemes to remote areas. Here, the road accessibility is categorized into three categories viz., '*pucca*', '*kuchha*' and '*footpath*'. The house which is accessed by '*pucca*' (metalled) road has zero percentage of '*firewood only*' use as cooking fuel and the percentage high (34.6%) substantially in those house which is access only by '*footpath*'. On the other hand, the percentage use of '*LPG only*' is considerably high (47.5%) in the house which is access by '*pucca*' road whereas the percentage is low among house which is access by '*kuchha*' (3.3%) and '*footpath*' (10.0%). In mixed fuel use, the percentage is high among the house which is access by '*kuchha*' (93.4%) where there is slight difference in '*pucca*' and '*footpath*' category. Therefore, it can be generalized that the house having access to '*pucca*' road has high percentage use of LPG and it is the opposite in the case for the house connected by '*kuchha*' and '*footpath*'.

The 'distance to travel to access LPG' cylinder is also a major factor for its use. In general, higher the distance to access LPG cylinder, lower will be the chance of its use. This also shows the lack of LPG distribution system due to which one have to travel to certain distance to refill the cylinder. In the study area, the distance is categorized into two categories viz., '*1 km/below 1km*' and '*above 1 km*'. The data reveals that those household which have to travel '*1 km/below 1km*' has high percentage (24%) of LPG use and low percentage of firewood use (10%); the mixed fuel is also high among this category (66%). On the other hand, the percentage of firewood use is high (51.7%) among those households which have to travel a distance of '*above 1 km*' to refill a LPG cylinder; while the low percentage of LPG use (3.3%) as well as mixed fuel use (45%) is observed (45%). It shows that the geographical or physical factor like distance is an important factor in accessing the LPG use in Sikkim. The data reveals that the lesser the distance to travel to refill the LPG cylinder, higher the percentage of LPG use in rural Sikkim. Therefore, the supply side mechanism of LPG cylinder supplies from the government needs to improve for the better picture of LPG use in rural Sikkim.

In terms of ‘cultivation of land’, the percentage of firewood only use is high (34.4%) among those household which cultivates lands last year while the LPG use is low (1.4%) and mixed fuel is 64.2%. Contrarily, the LPG use is very high (53.1%) among those household which did not cultivate land last year and the firewood use very low (1.1%) among them and also mixed fuel use (45.8%). This reveals that the cultivation of land also have important factor which determine the use of fuels in rural Sikkim which is primarily because of the livelihood practices associated with the household. Likewise, the livestock is one of the important factors which determine the fuel choice. Here, it is observed that the household having livestock has high percentage (30.0%) of *‘firewood only’* use and low percentage (2.9%) of *‘LPG only’* use. In other words, the percentage of firewood use is high among the house which owned livestock than the household which do not possess any livestock. It is also observed that the percentage of household which uses *‘mixed’* is high (67.1%) in the household which owns livestock which further justify the statement that the livestock has important role in fuel choice. A similar study also justifies this statement which was carried out by Treiber, Grimsby and Aune 2015.

Likewise, the percentage of firewood use is substantially high (36.2%) among *‘BPL’* household than the *‘APL’* household and the percentage use of *‘LPG only’* is considerably low (8.7%) among *‘BPL’* household. It is noticed that the percentage use of *‘LPG only’* is very high among *‘APL’* household (33.5%) and they also tend to depend on *‘mixed’* fuel (66.0%). This is directly links with the income level which in turn determines the various cooking fuesl; higer clean fuel use in high income groups and low for the lower income groups (Lewis and Pattanayak 2012; Mekonnen & Kohlin, 2009; Rao & Reddy 2006; Behera Dash & Yadav 1991; Duflo et al 2008).

The banking service is important to avail welfare schemes/services. Here, it is observed that the percentage of household having banking services has high percentage (19.5%) of *‘LPG only’* use than the household that do not have banking services (3.9%). Contrarily, the percentage of *‘firewood only’* use is high among the household that do not banking services (62.1%). Further, the *‘mixed fuel’* use is also high (63.8%) among the household that have banking services. Similarly, the percentage of household that do not have *‘Sikkim Subject/Certificate of Identification (COI)’* have high (71.4%) percentage use of *‘firewood*

only' than those household that have. However, there is not so much variation '*LPG only*' use but it does have high percentage in '*mixed*' fuel use (66.4%).

Overall, the state percentage of '*firewood only*', '*LPG only*' and '*mixed*' fuel use are 24.5%, 16.8% and 58.7% respectively where majority of household depend on '*mixed*' type of fuel i.e firewood and LPG. Among the four districts, the South district has the highest percentage of firewood use whereas North district (15.3%) is the least. However, in terms of LPG use, East district has fairly high percentage (29%) with above state average (16.8%). In terms of '*mixed*' fuel use, North district has the highest percentage (73.3%) because of the factors like cold weather condition in the maximum part of the year along with the food habit and cultural-tradition practices. It is observed that the dependence on '*mixed*' fuel is high in rural Sikkim which implies that there is no certainty or fuel security.

In social context, it is observed that the '*Bhuddhist and 'Animinism/Yumanism*' religion household have the high percentage use of firewood. In addition, ST and SC have high percentage of '*firewood only*' use and low dependence on '*LPG only*' use. It is because of the socio-cultural and livelihood practices associated with these groups. Further, the socio-economic and geographical factors like '*small family size*', '*female headed household*', '*higher education of household head*', '*pucca house type*', '*accessibility of pucca road*', '*household having banking services*' and '*APL household*' are important factors in the accessibility of LPG which observed the high percentage use in rural Sikkim.

8. Summing up:

In a nutshell, it is observed that the percentage of '*mixed*' fuel is considerably high across all socio-economic and geographical regions which are followed by '*firewood only*' use and '*LPG only*' use. Treiber, Grimsby and Aune (2015) found that availability of fuel is also one of the main determinants of having more than one fuel in stock. It shows that the rural Sikkimese people tend to depend more than one cooking fuels mainly because of the nature of their work, agricultural practices, animal domestication, availability of alternative cooking fuels, irregular/infrequent distribution of LPG system, fuel security, food and taste factors, cultural and traditional factors. Although the percentage of '*firewood only*' dependent household has been decreasing but the use of '*mixed fuel*' has been high. Even there is

improvement in the socio-economic condition and the transformation from agriculture to non-agriculture sector in rural Sikkim, people are still not going to shift from firewood to clean fuel i.e. LPG completely because of the socio-economic and cultural practices. Therefore, there is distant chance of complete fuel switch from unclean fuel (firewood) to clean fuel (LPG) in rural Sikkim.

CHAPTER 5

DETERMINANTS OF HOUSEHOLD COOKING FUEL USE IN SIKKIM

1. Factors Affecting Fuel Choice:

The energy transition or fuel switching has become one of the priority areas for most of the developing countries. This is because of its direct benefit associate with it in terms of health, environment and poverty reduction. The energy transition generally means shifting of households from using fuels in lower rung of energy ladder to higher rung of the energy. In other words, households' preference ranges from inefficient fuels such as dung, crop residue, firewood through more efficient fossil fuels to the most modern form of energy (Holdren and Smith 2000; Leach 1992). According to the "energy ladder" theory in its simplest fundamental idea, income is the sole factor for fuel switching. Further, households use higher rung of energy with the expense of lower rung of energy ladder completely. However, several factors which affect household's fuels choice and patterns of use are put forward by various studies.

It is found that firewood is an important source of fuel in low income households and as households become more affluent, more likely to switch to improved fuels from solid to liquid and finally to gaseous fuels for cooking (Gupta and Ravindranath 1997). Gupta and Kohlin (2006); Link, Axinn and Ghimire (2012) also state that the household income is considered as the single most determinant of fuel choice. However, Masera et al (2000) confirmed that energy transition is not a simple linear progression from traditional to modern fuels as income increases. In other words, households do not switch completely from one fuel to another; rather they adopted modern fuel without dispose of the earlier traditional fuels. The reason for this multiple fuel use is due to households' maximization of fuel security, technical and cultural preference. (Joon et al 2009). Thus, it is said that multiple fuel use patterns is a product of complex interactions among economic, social and cultural factors. Similarly, Heltberg (2005) examine the factors determining fuel choice in Guatemalan households experienced multiple fuels used for cooking by 48% of urban households and 27% of rural households. The study found that opportunity cost related to biomass fuel apart

from income level is an important determinant of fuel choice. The study also explains other factors which influence fuel choice such as education, electrification, and price of fuels.

The electrified households also have a higher incidence using modern fuel compared to non-electrified households (Duflo et al, 2008; Heltberg, 2004, 2005). Moreover, energy ladder theory is very problematic in rural settings than urban settings where household choice in rural areas is also determine by local availability without monetary expenditure or low marginal cost such as dung, crop residue, woods, and twigs (Bruce et al, 2011; Farsi et al, 2007; Heltberg, 2005; Masera, 2000). It is even more pronounced when considering high transaction cost, poor access and unreliable supply of modern fuel in rural areas.

The demographic dynamics are important drivers of environmental change and it has major role to play in climate change (Jiang and O'Neil 2009). The household is the basic unit of energy consumption as the demand for energy has been increasing continuous to match with the waves of economic and globalised world. Changes to population size, age structure, and urbanization, as well as changes in household living arrangements are some important demographic dynamics which have crucial role in development and environment interplay. A study conducted in rural India (Pandey & Chaubal 2011) using 61st Round of National Sample Survey observed an apparent association of various socio-economic factors with the uptake of clean cooking fuels. It is found that regular salary income and monthly per capita consumption expenditure have a positive effect on clean cooking fuel use whereas households having below poverty line card, family size, size of farm land, and belonging to reserved social groups have a significant negative association.

In India, it is estimated that environmental factors accounts 20% of burden of diseases which are mainly linked with dimensions of poverty e.g. malnutrition, lack of access to clean energy and water (National Environment Policy 2006). The economic condition of household has a major role in affording the clean cooking fuel. It is very difficult to afford “clean cooking fuel” especially to poor and rural population. As household gain socioeconomic status, they switch to the modern and clean fuel consumption abandoning polluting fuels like cow dung, wood, charcoal and also insufficient cooking appliances (Smith, 1987; Barnes & Floor 1996).

Accessibility of clean fuel like LPG is also determined by the regulated pricing and black markets and also affected by uncertain availability and supply side shocks (Gupta and Kohlin 2006). Further, the fuel choice is also influenced by the individual characteristics, culture and tradition practices of region (Treiber, Grimsby and Aune 2015). According to “ladder model” the income group and the urbanization are important for fuel choice. It also state that modern fuel use is positively correlated with electrification of the household; contrarily usage of solid fuels declines in response to electrification. Likewise, expenditure, urbanization, level of education and household having tap water inside the house are driving force associated with fuel switching in most cases in a positive way towards cleaner and more efficient modern fuels. It is also observed that larger households tend to use a greater number of fuels, both solid and non-solid (World Bank 2003). Energy economization is an important reason for energy diversification (Treiber, Grimsby and Aune 2015). In diverse countries like India, the “multiple fuel model” has its relevance than typical energy ladder model (Pachauri and Spreng 2003).

A cross country analysis revealed that, there is positive relationship between economic growth and modern fuel consumption suggesting that “as a country progresses through the industrialization process, its reliance on petroleum and electricity increases and the importance of biomass decreases” (Hosier and Dowd 1987). The factors like costs of cylinders, appliances and connections may affect the willingness of households to switch from fuel wood to commercial alternatives (Horst and Hovorka 2008). Though income has important role in energy choice, but it becomes irrelevant if energy carriers and technologies are not physically available. Therefore, it is very essential to have efficient distribution system to reduce the energy poverty (Treiber, Grimsby and Aune 2015). There are many factors which determine the use of cooking fuels. Broadly, the physical, economic and social barriers have greater role to play. Besides, these broad factors, the factors like convenience of cooking fuel is also important determinants in accepting cooking fuel especially rural areas. The choice and acceptance of cooking energy is strongly influenced by the convenience of using it which is embedded in socio-cultural settings of the population (Atanassov 2010). The final choice of cooking fuel is also influence by the type of food typed, quantity prepared and type of stoves. Taste preference and time are also play an important role in household cooking energy use; availability of fuel is also one of the main determinants of having more

than one fuel in stock. In addition, it is also influenced by the seasonal availability of firewood and agriculture residuals which leads to multiple stove use. Therefore, fuel affordability and availability are major issues in terms of fuel choice (Treiber, Grimsby and Aune 2015). The geographical or climate variations are also important factors which affect firewood availability. The growth in traditional assets as live stokes is likely to put press on forest whereas the pressure on forest is less if the growth in education and nonfarm assets took place (Baland, Bardhan, Das, Mookherjee, Sarkar 2010).

It is often argued that the consumption of modern cooking fuels is associated with access to other infrastructure services. It is suggests that modern cooking fuels and electrified household is also related, it is observe that the electrified household tend to adopt modern cooking energy across all level of income. Further, access to an improved water source also enhances modern cooking fuels (World Bank 2003). The gender aspect in firewood collection process where female spends most of time is another important factor in fuel choice (Hassan, Halder, Pelkonen and Pappinen 2013).

Urbanization process is also seen as the alternative way of providing clean energy. The rate of urbanization also influence the household energy consumption pattern, as the urbanization increases, there is lesser chances of firewood use demand (Arnold, Kohlin and Persson 2006). The variables like household expenditures, education, urbanization, electrification status, and water source tend to affect in fuel choice and fuel switching decision or between modern and traditional solid fuels. It is observed that household size tend to increase the use of all energy sources – it matters for fuel choice but not for switching. The physical infrastructure services like electricity, water supply, roads, and cooking fuels are also important in determining household cooking energy use (World Bank 2003). It is considered that the urbanization along with income, energy prices, energy access and local fuel availability are key drivers of the energy transition in developing countries like India and China (Pachauri and Jiang 2008). The study of household energy transition in India and China found urbanization, energy prices, energy access, and local fuel availability are key drivers for adoption of clean fuel besides income in both the country.

The factors such as household income, energy prices, costs and quality of supply and urbanization along with demographic differences and geographic variations are major

determining factors in household energy choices. In comparative study of India and China, it is found that level of education of head of the household have an influence on energy choices (Pachauri and Jiang 2008). The household's capacity such as access to resources like labor, land, and money along with the other factors, such as access to "Common Property Resources(CPRs)" and the availability and price of substitute fuels also determine the response to fuel wood shortage (Arnold, Kohlin and Persso 2006). The World Bank reports states that the use of LPG is influence by household size; which means higher the chances of LPG use among larger household size. In other words, large households are more likely to use both solid and non-solid fuels. On the other hand, unlike LPG, the probability of using kerosene depends on household size in the opposite manner i.e. larger for small households (World Bank 2003).

Leach (1992) expressed that apart from income level of households, the major obstacle to attain higher rung of energy in developing countries is due to poor access situation. Viswanathan and Kumar (2003) state that "high distribution costs for remote and sparsely populated areas make the supply of commercial energy a difficult task in rural India" (p.1022). In their analysis in India, they found a huge difference in rural and urban expenditure share of clean fuel (kerosene, gobar gas and LPG) and also seen significant differences across the states. They found the main culprit to these low shares of expenditure on clean fuel is low economic status and lack of access to clean fuel. It is given that there is a significant correlation between expenditure on clean fuel and economic status and its growth overtime. Lack of access to clean fuels is due to high initial cost for adoption and pro-urban and pro-rich subsidy is also noted.

Farsi et al (2007) highlight the significant proportion of urban households that rely on biomass fuel as their primary cooking energy besides greater access to cleaner fuel and equipments compared to rural India. Moreover, study also reveals that those household lives in metros and larger cities have the higher probability of using cleaner fuel because of greater accessibility. Budget constraints and price of fuels are important determinants of fuel choice by the people as higher the income, higher is the probability of switching from biomass to cleaner fuel and substitution effect occurred due to relative prices of the fuels. Overall,

households with better economic condition, education, and empowered of women are more likely to use modern efficient fuel in urban India.

A study (Lewis and Pattanayak 2012) which review the various empirical studies explore a wide range of socioeconomic determinants of fuel and stove choice such as income, education, household size, location, religion, social groups, credit access, and fuel prices (also see Mekonnen & Kohlin 2009; Rao & Reddy 2006). Both, adoption of improved cooking stoves and clean fuels choice are directly associated with income and education (head of household and female) whereas socially marginalized status (SC/ST) are indirectly associated. The study also showed that for either adoption of improved stoves or decision to purchase an improved cooking stove were positively influenced by fuel wood price, household size and availability of credit and negatively influenced by age of the head of household and price of LPG. Further, switching from biomass fuel to cleaner fuel is enhanced for households with female head, access to electricity and higher female education, however, worse for male education and households working in agricultural and casual labor. Better off households (Behera Dash & Yadav 1991; Duflo et al 2008) and households resides in urban areas (Lewis and Pattanayak, 2012) are more likely to use cleaner stove that use clean fuel. Several studies also expose that apart from income there is a high and positive correlation between using clean fuel with women empowerment, education, sex of the head of household and accessed to electricity. A study on financial analysis of cooking energy options conducted by (Gupta and Ravindranath 1997) based on fuel-device combination found that efficiency of the device is a crucial factor in determining total cost of the fuel-device choice. The result of the study shows that, in rural area, poorest section of the society uses traditional biomass stove with highest cost among wood-burning stoves. Firewood burned in the efficient improves biomass stove was observed to be lowest total cost whereas LPG and biogas were the most expensive option. However, firewood burned in traditional stove was expensive than subsidized kerosene options. On the other hand, in urban area, due to relatively higher price of firewood subsidized kerosene is the cheapest option. Even though, improves biomass stove option is between subsidized and market price kerosene, with or without subsidy kerosene remains cheaper option than traditional firewood stove combinations. Interestingly, traditional firewood stoves combination is even higher cost options than subsidized LPG but lower to market price LPG.

Although, it is said to be very effective in reduction of IAP by switching from wood, dung, charcoal, or crop residue to more efficient modern fuels, access to these alternatives is very limited for most of the developing countries. This is because of the fact that relationship between reliance on traditional fuels and poverty is a two way. The financial constraints of the poor households do not permit switching to more efficient, cleaner fuels (Bruce et al, 2000). On the other hand, using traditional fuels leads to adverse health affect, women time and opportunities loss for income generation which in turns inhibits the households attempt to escape from poverty (Lewis & Pattanayak 2012). According to their study, it is almost impossible to achieve complete switching of fuel in near future as International Energy Agency (IEA) estimates that upto 2030 more than 3 billion people will rely on solid fuel.

The determinants of cooking fuel also vary from region to region. Therefore, the efforts to have been made to analyze the determinants of household cooking fuel from various socio-economic aspects in Sikkim.

Household cooking fuel use and geographical factors:

The geographical or physical factors are the most important aspects in defining a region. It is the geographical factors which leads a process of regionalization. It is important to contextualize the geographical factors of a region to understand the existing phenomena like socio-economic settings. In other words, the socio-economic setting of a place or a region is greatly influence by its geographical/physical settings. The effects of geographical/physical factors can be observed prominently in the Himalayan or mountainous area and rural areas. In mountainous area, life is tough because of its topography; and people have to cope with harsh conditions. In this process, the supply side mechanism of government's social schemes is also greatly disturbed. For instance, the provision of LPG distribution system is greatly affects with the unpredictable nature of topography. Therefore, in this context the household cooking fuels in rural Sikkim has been analyzed by taking factors like distance, urbanization are taken into consideration which generally determines the LPG use.

5.1 Household cooking fuel use across geographical factors in study area (rural Sikkim)

		Primary source of cooking fuels (in number)			Geographical factors	
		Firewood only	LPG only	Mixed (LPG & firewood)	Distance	Urban population (%)
East District	Assam Lingchey	1	25	18	1 km/below 1 km	43.19
	Pacheykhani	0	4	15	1 km/below 1 km	
	Subaneydara	31	0	6	Above 1 km	
North District	Namok	5	8	17	1 km/below 1 km	10.62
	Shipgyer	18	0	30	Above 1 km	
	Lachen	0	9	63	1 km/below 1 km	
West District	Gerethang	0	8	24	1 km/below 1 km	3.85
	Chakung	9	4	38	1 km/below 1 km	
	Barnyak	17	11	39	1 km/below 1 km	
	Mabong	9	0	22	Above 1 km	
	Karthok	2	4	13	1 km/below 1 km	
South District	Rong	15	5	30	Above 1 km	14.44
	Chuba	36	2	17	Above 1 km	
	Bermiok	4	21	20	1 km/below 1 km	
Total		147 (24.50%)	101 (16.8%)	352 (58.70%)		

Source: Field survey.

The two important geographical factors viz., distance and urbanization have been analyzed. The geographical ‘distance’ is one of the factors that are responsible for the LPG use; higher the distance to travel to access LPG cylinder, lower will be the chance of its use. The same story reveals in the study as well. The ‘distance’ is categorized into two category viz., ‘1 km/below 1 km’ and ‘above 1km’ to travel to access LPG. Based on this criterion, it is observed that the villages which are located within or have to travel ‘1 km/below 1 km’ distance to get access the LPG cylinder, they use more LPG as compared to those villages from where they have to travel ‘above 1km’. In other words, the distance is inversely proportional to LPG use; higher the distance to travel to access LPG cylinder, lower will be its use. For instance, Subaneydara (East district), Shipgyer (North district), Mabong (West district), Rong (South district) and Chuba (South district) where it can be clearly observe that the use of LPG as per distance. It is observed that the LPG use is very low in these villages where people have to travel ‘above 1km’ to access LPG cylinder refill. The use of firewood as fuel is prominent in these villages. On the other hand, the villages where distance to travel is ‘1 km/below 1 km’ to access filled LPG cylinder they have high LPG use as primary

cooking fuel whereas firewood use is significantly low. The data justify the statement that the geographical factor has 'distance' important aspect in accessing the LPG.

Likewise, the urbanization is one of the factors which influence the LPG use; higher the urbanization higher will be the LPG use. The process of urbanization influences not only the urban area but also the surrounding areas. It is also seen that urbanization process as the alternative way of providing clean energy by resolving the issue of firewood crisis. The rate of urbanization also influence the household energy consumption pattern, as the urbanization increases, there is lesser chances of firewood use demand (Lewis and Pattanayak 2012; Arnold, Kohlin and Persson 2006; Behera Dash & Yadav 1991; Duflo et al 2008; Horst and Hovorka 2008; World Bank 2003). The relation between urbanization and fuel use is also observed in the study are. Here, the urbanization is analyzed with the help of urban population of four districts; due to small geographical area the process of urbanization greatly influence the surrounding regions or villages of Sikkim. Among the four districts, East district has highest urban population of 43.19%, followed by South district (14.44%), North district (10.62%) and lowest is 3.85% (West district). The 'LPG only' use is high in East district (29 households) and South district (28 households) which corresponds with the high urban population. On the other hand, West district and North district has low urban population which also observed low LPG only use. Therefore, it is evident from the table that the urbanization is directly/positively relates with the clean fuel use i.e LPG use in Sikkim. In other words, higher the urban population higher will be the LPG use as cooking fuel.

2. Determinants of household cooking fuel in Sikkim: A supply side analysis

A wide range of socioeconomic determinants such as income, education, household size, location, religion, social groups, credit access, and fuel prices influence the fuel choice (Lewis and Pattanayak 2012; Mekonnen & Kohlin, 2009; Rao & Reddy 2006). There is direct relation between the adoption of improved cooking stoves and clean fuels choice with income and education (head of household and female) whereas socially marginalized status Scheduled Caste (SC)/Scheduled Tribe (ST) are indirectly associated. In addition, fuel wood price, household size, and availability of credit and negatively influenced by age of the head of household and price of LPG. The households with female head, access to electricity and higher female education, however, worse for male education and households working in

agricultural and casual labor are also determine the fuel choice. Therefore, here, efforts have been made to determine various factors in cooking fuel. The multinomial logistic regression has been used to explain the supply side variables. The model for multinomial logistic regression is given as follows:

$$\text{Log} \left(\frac{\text{Pr}(Y=k)}{\text{Pr}(Y=k')} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_k X_k + \epsilon_{ij}$$

Where, 'k' is the indentified category i.e. primary source of cooking fuel other than reference category) and k' is the reference category. X's are the various explanatory variables. β 's are the regression co efficient associated with each explanatory variables.

The explanatory variables in the model are:

1. Received LPG from Government: LPG connection received from the government
2. Affordability of LPG = Household can afford LPG connection/cylinder refill
3. Delivery Timing = LPG delivery timing
4. LPG distribution system = LPG distribution system
5. Distance to travel to get LPG = Distance to travel to get LPG cylinder

Table 5.2: (Model 1): Multinomial Regression (Supply Side)

Model - I	LPG				Mixed (LPG+ Firewood)			
Supply Side Variable	Exp(B)	LL	UL	Sig.	Exp(B)	LL	UL	Sig.
Received LPG from Government								
No [®]								
Yes	4.810	.845	27.385	.077	3.254	7.312	1.978	.000***
Affordability of LPG								
No [®]								
Yes	3.667	9.435	5.794	.000***	1.462	67.914	4.5	.000***
Delivery Timing								
Not Fixed [®]								
Fixed	2.464	.267	22.728	.426	.603	.066	5.480	.653
LPG distribution System								
No [®]								
Yes	1.378	.493	3.855	.541	2.650	1.051	6.63	.039**
Distance to travel to get LPG								
More Than 1 KM [®]								
Less or Equal to 1 KM	1.664	7.509	231.187	.000***	6.995	2.442	20.03	.000***
Sample Size	600							
Nagelkerke	.724							
P-Value	0.00							
a. The reference category is: firewood.								

[®] Reference Category

p-value: ***<0.01, **<0.05 and * <0.1

The model 1 (table 5.2) tries to analyze the supply side variables that are likely to determine the household cooking fuel controlling other variables. To analyze such aspect, the multinomial regression is best suited statistical method as dependent variable is categorized into three i.e. (Primary source of fuel for cooking) viz., *'firewood only'*, *'LPG only'* and *'mixed'* (LPG and firewood).

The dependent variable is *'primary source of fuel for cooking'* with reference category *'firewood only'* among other two category viz., *'LPG only'* and *'mixed'*. With sample size of 600, it has Nagelkerke value of (.72) which means about 72% of the model is explained by the selected variables. There are five independent variables for regression analysis under which three variables are coming significant at 95% level of confidence viz., *'received LPG from government'*, *'affordable of LPG'* and *'distance to travel to get LPG'*. With reference to *'received LPG from government'* the likelihood of household to use *'mixed'* fuel is high among those who has received LPG from government than who did not. However, in both *'affordable of LPG'* and *'distance to travel to get LPG'* are coming significant at 95% level of confidence in *'LPG only'* and *'mixed'* reference category. This means the likelihood of *'LPG only'* and *'mixed'* use is comparatively high than *'firewood only'* use for those who can *'affordable of LPG'* and have *'less or equal to 1 km distance'* to travel to get LPG.

It can be said that three factors viz, *'received LPG from government'* and *'distance to travel to get LPG'* and *'affordable of LPG'* are determining factors in accessing *'LPG only'* and *'mixed'* fuel use in Sikkim. The role of government in providing services like free and affordable LPG and its regular distribution system is felt to provide clean fuel for all.

2.2. Determinants of household cooking fuel in Sikkim: A supply and social side analysis

The multinomial logistic regression has been used to explain the supply side and social side variables. The model for multinomial logistic regression is given as follows:

$$\text{Log} \left(\frac{\text{Pr}(Y=k)}{\text{Pr}(Y=k')} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_k X_k + \epsilon_{ij}$$

Where, 'k' is the indentified category i.e. primary source of cooking fuel other than reference category) and k' is the reference category. X's are the various explanatory variables. β 's are the regression co efficient associated with each explanatory variables.

The explanatory variables in the model are:

1. Household Banking = Household have banking service
2. BPL family = BPL household
3. HH Certificate of Identification (COI) = Household have Certificate of Identification (COI)
4. HH MGNEGRA/Job = Household have MGNEGRA/Job card
5. HH SHGs/bandhan = Household have Self Health Groups/bandhan service
6. Aware about govt. schemes = Aware about government schemes
7. Household member attend public meeting = Household member attend public meeting
8. Affordability of LPG: Household can afford LPG connection/cylinder refill
9. Received LPG from govt. = LPG connection received from the government
10. LPG is easily obtained when in need = LPG can be easily obtained when in need
11. Distance to travel to get LPG = Distance to travel to get LPG cylinder
12. LPG distribution system = LPG distribution system

In model 2 (table 5.3), the dependent variable is same as in model 1. However, the analysis aspect is from social and supply side variables aspects controlling other variables. There are 12 independent variables in the analysis. It has Nagelkerke value of (.762) which means about 76% of the model is explained by the selected variables.

It is observed that 6 variables are coming significant among the 12 independent variables. The variables like '*BPL household family*' and '*affordability of LPG*' are coming significant at 95% level of confidence. As compared to firewood, the likelihood to switch to LPG and '*mixed*' is comparatively high in APL family than BPL. Similarly, those who can '*afford LPG*' have high likelihood to use LPG and '*mixed*' than who responded '*no*' among the firewood user. The likelihood of LPG use is comparatively higher than '*firewood only*' use for those who are aware about government schemes. Similarly, the likelihood of using LPG and '*mixed*' is comparatively higher than '*firewood only*' use for those who have received LPG from government. In '*distance to travel to get LPG*' the likelihood of household to use LPG and '*mixed*' is high in distance '*less than 1 km*' than '*more than 1 km*'. The likelihood of '*mixed*' fuel use is high where there is '*regular*' distribution system than '*irregular*' system.

Table 5.3: (Model 2): Multinomial Regression (supply + social side)

Model 2								
Social variables	LPG				Mixed (LPG+ Firewood)			
	Exp(B)	LL	UL	Sig.	Exp(B)	LL	UL	Sig.
Intercept				.256				.954
Household Banking								
No®								
Yes	.648	.126	3.331	.604	.420	.121	1.462	.173
BPL family								
No®								
Yes	.004	.000	.082	.000***	.005	.000	.100	.000***
HH Certificate of Identification (COI)								
No®								
Yes	.653	.161	2.649	.550	1.763	.542	5.732	.346
HH MGNEGRA/Job card								
No®								
Yes	.470	.144	1.533	.211	.846	.282	2.541	.766
HH SHGs/bandhan								
No®								
Yes	.498	.156	1.595	.241	.661	.226	1.939	.451
Aware about govt. schemes								
No®								
Yes	3.881	.999	15.076	.050**	1.885	.511	6.951	.341
Household member attend public meeting								
No®								
Yes	3.084	.425	22.402	.266	3.585	.553	23.245	.181
Affordability of LPG								
No®								
Yes	470.870	44.409	4992.691	.000***	161.626	45.341	576.146	.000***
Received LPG from govt.								
No®								
Yes	8.534	1.272	57.242	.027**	59.495	10.541	335.792	.000***
LPG is easily obtained when in need								
No®								
Yes	.101	.006	1.621	.105	.026	.002	.446	.012**
Distance to travel to get LPG								
More Than 1 KM ®								
Less or Equal to 1 KM	18.493	3.147	108.669	.001***	4.494	1.488	13.576	.008***
LPG distribution system								
Irregular®								
Regular	2.890	.951	8.784	.061	3.605	1.321	9.839	.012**
Sample Size	600							
Nagelkerke	.762							
P-Value	0.00							

a. The reference category is: firewood.

® Reference Category

p-value: ***<0.01, **<0.05 and * <0.1

It can be said that the social factors like ‘BPL household’, ‘awareness about the government schemes’, ‘income’, ‘LPG received from government’, ‘distance to travel to get LPG’ and ‘LPG distribution system’ are important factors in accessing the clean cooking fuel or transition from ‘firewood only’ to LPG use in Sikkim. Therefore, it is suggestive to strengthen the government policy to review the LPG distribution policy as well as create mass awareness among people about the LPG use and its benefit. It is suggestive to provide some kind of subsidiary support to all BPL families from government in refilling LPG cylinder.

2.3. Determinants of household cooking fuel in Sikkim: An analysis of socio-demographic, supply side and physical aspect

The multinomial logistic regression has been used to explain the socio-demographic, supply side and physical variables. The model for multinomial logistic regression is given as follows:

$$\text{Log} \left(\frac{\text{Pr}(Y=k)}{\text{Pr}(Y=k')} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_k X_k + \epsilon_{ij}$$

Where, ‘k’ is the identified category i.e. primary source of cooking fuel other than reference category) and k’ is the reference category. X’s are the various explanatory variables. β ’s are the regression coefficient associated with each explanatory variables.

The explanatory variables in the model are:

1. Household Banking = Household have banking service
2. BPL family = BPL household
3. HH Certificate of Identification (COI) = Household have Certificate of Identification (COI)
4. HH MGNEGRA/Job = Household have MGNEGRA/Job card
5. HH SHGs/bandhan = Household have Self Help Groups/bandhan service
6. Aware about govt. schemes = Awareness about government schemes
7. Education level who usually cooks in HH = Education level who usually cooks in a household
8. Received LPG from govt. = LPG connection received from the government
9. Getting schemes from PDS = Household getting schemes from Public Distribution System (PDS)

10. Distance to travel to get LPG = Distance to travel to get LPG cylinder
11. Type of family = Type of family
12. Sex of the household head = Sex of the household head
13. Number of room in house = Number of room in a house
14. Nature of work HH = Nature of work of Household
15. Electricity use in heating = Electricity use in heating purpose
16. Household decision on financial affairs = Household decision on financial affairs
17. Household decision on cooking fuel = Household decision on cooking fuel
18. Awareness about forest rules and regulations = Awareness about forest rules and regulations
19. Awareness about indoor air pollution = Awareness about indoor air pollution

In model 3 (table 5.4), variables have analyzed combining supply side, socio-economic-demographic and physical aspects. There are 19 independent variables for regression analysis and out of which 7 variables are coming significant. The Nagelkerke value of (.778) which means about 77% of the model is explained by the selected variables.

It is observed that those who have '*banking services*' are more likely to use LPG and '*mixed*' fuel. In other words, those who have banking services are more likely to use LPG and '*mixed*' fuel than those who do not have banking services. The likelihood of use of '*LPG only*' and '*mixed*' is comparatively higher among APL than BPL family. Similarly, the likelihood of LPG and '*mixed*' use is comparatively higher to those who have received LPG from government. With reference to '*distance more than 1 km*', the likelihood of household using LPG and '*mixed*' fuel is higher in '*distance less than 1 km*'. In terms of number of room, '*small numbers*' (1-2) of rooms are more likely to switch to LPG than large number of rooms (5-8 and 3-4). Likewise, the household who engage in agriculture is more likely to switch to LPG and '*mixed*' fuel than non-agriculture. Further, the likelihood of LPG use is high for those who are aware about the indoor air pollution. Similar study was done by Pandey & Chaubal (2011) where it is found that the households having below poverty line card, family size, size of farm land, and belonging to reserved social groups have a significant negative association with clean fuel use.

Table 5.4: (Model 3): Multinomial Regression (Socio-demographic & environment side)

Model 3: Selected variables	LPG				Mixed (LPG+ Firewood)			
	Exp(B)	LL	UL	Sig.	Exp(B)	LL	UL	Sig.
Intercept				.880				.696
Household Banking								
No®								
Yes	6.740	1.25	36.10	.026**	2.88	1.25	6.64	.013**
BPL family								
No®								
Yes	.012	.000	.315	.008***	.013	.001	.300	.007***
HH Certificate of Identification (COI)								
No®								
Yes	.690	.129	3.694	.665	2.603	1.06	6.336	.035**
HH MGNEGRA/Job card								
No®								
Yes	.502	.167	1.509	.219	.951	.377	2.396	.915
HH SHGs/bandhan								
No®								
Yes	1.407	.462	4.290	.548	2.060	.860	4.933	.105
Household member attend public meeting								
No®								
Yes	1.912	.286	2.786	.504	1.484	.326	6.758	.610
Education level who usually cooks in HH								
Higher®								
Illiterate	.266	.012	5.908	.403	7.751	.456	131.6	.156
Primary/below primary	.211	.011	4.137	.305	7.707	.467	127.2	.153
Secondary	.686	.036	13.21	.803	10.073	.596	170.2	.109
Received LPG from govt								
No®								
Yes	1.35	2.47	1.8	.005***	1.81	21.8	2.8	.000***
Getting schemes from PDS								
No®								
Yes	.760	.272	2.118	.599	1.173	.538	2.557	.689
Distance to travel to get LPG								
More Than 1 KM ®								
Less or Equal to 1 KM	9.011	1.27	63.84	.028**	2.879	1.14	7.258	.025**
Type of family								
Joint®								
Nuclear	2.307	.620	8.593	.213	2.057	.805	5.258	.132
Sex of the household head								
Female®								
Male	.265	.047	1.479	.130	.509	.123	2.096	.350
Number of room in house								
5 - 8®								
3 - 4	3.740	.169	82.81	.404	.334	.036	3.068	.332
1 - 2	3.121	.965	10.08	.057**	.717	.291	1.765	.469
Nature of work HH								
Non-agriculture®								
Agriculture	.003	.000	.026	.000***	.116	.032	.412	.001***

Electricity use in heating								
No®								
Yes	1.947	.472	8.026	.357	2.313	.734	7.286	.152
Household decision on financial affairs								
Men®								
Women	1.771	.420	7.472	.436	.608	.186	1.991	.411
Household decision on cooking fuel								
Men®								
Women	6.481	.729	57.57	.094	.882	.284	2.739	.828
Awareness about forest rules and regulations								
No®								
Yes	2.101	.489	9.0	.319	2.369	.648	8.656	.192
Awareness about indoor air pollution								
No®								
Yes	5.045	1.34	18.8	.016**	1.802	.605	5.362	.290
Sample Size	600							
Nagelkerke	.778							
P-Value	0.00							

a. The reference category is: firewood.

® Reference Category

p-value: ***<0.01, **<0.05 and * <0.1.

3. Summing up:

It can be state from the above three models that the variables like *'received LPG from government, 'LPG distribution system', 'distance travel to get LPG' 'awareness about government schemes', 'affordability to LPG'* are major determinants of household cooking fuel use in rural Sikkim. Therefore, it is imperative to improve these factors to make LPG available and accessible to all rural people. In general, *'income' and 'supply side'* variables are important factors in accessing the LPG in rural Sikkim. Therefore, the role of government policy seems to play a major role in providing free LPG connection to rural people. In addition, it is also observed that majority of people are likely to use more than two fuels i.e. *'mixed'* type in rural Sikkim. This is mainly because of the nature of the work that rural people engaged like agriculture and livestock practices along with the socio-cultural practices, fuels security and availability of alternative fuel in rural areas i.e firewood.

CHAPTER 6:

INTERVENING FACTORS IN ACCESSING COOKING FUELS

1. Introduction:

According to the Energy Poverty Action initiative of the World Economic Forum, "Access to energy/fuel is fundamental to improving quality of life and is a key imperative for economic development"¹⁹ The term 'accessibility' is difficult to define in a single word; it is sometimes synonymously use with the term 'availability'. However, there is difference between these terms. In simple word, it can be explained that, 'availability' simply means the presence of services or goods but the concept of 'accessibility' is larger than that. For instance, an individual cannot access some goods and services despite of its 'availability' because of the capacity to afford it. The concept of 'accessibility' is larger and deeper in context underpin by various socio-economic factors. Likewise, the accessibility of various household cooking fuels also determine by the underlying socio-economic-environment factors. Therefore, it is imperative to analyze the concept of 'accessibility' in the study of household cooking fuels considering socio-economic-environment dynamics across geographical area. In addition, accessibility of clean fuel like LPG is also determined by the regulated pricing and black markets and also affected by uncertain availability and supply side shocks (Gupta and Kohlin 2006). The fuel choice and adaptation of new energy technologies are also influenced by the individual characteristics, culture and tradition practices of region (Treiber, Grimsby and Aune 2015). It is often argued that the consumption of modern cooking fuels is associated with access to other infrastructure services. It is suggests that modern cooking fuels and electrified household is also related, it is observe that the electrified household tend to adopt modern cooking energy across all level of income (World Bank 2003).

The location of Sikkim in Eastern Himalayan makes the 'availability' and 'accessibility' of clean cooking fuels bit cumbersome. However, despite the physiographic constraints, it is important to make clean cooking fuel available and accessible to every household in the larger context of environmental sustainability and health.

¹⁹ https://en.wikipedia.org/wiki/Energy_poverty

2. Fuel switching:

Fuel switching is a process where there is a complete transition from the unclean/traditional cooking fuels like cow dung, coal, firewood to clean cooking fuels like electricity, LPG etc. In simply, it is the level of fuel switching from unclean/tradition to clean/modern.

To understand the level of fuel switching from unclean/tradition to clean/modern, following categorial questions were asked to household members.

- No switching – the household consumes only solid fuel(s)
- Partial switching – the household consumes both solid and non-solid fuels
- Full switching – the household consumes only non-solid fuel(s)

Table 6.1: Level of fuel switching from unclean/tradition to clean/modern

Switching	Fuel use	Frequency (%)
No switching	HH consumes only solid fuel	147 (24.5)
Partial switching	HH consumes both solid and non-solid fuel	352 (58.7)
Full switching	HH consumes only non-solid fuel	101 (16.8)

HH=Household

Source: Field survey

From the above table 6.1, it can be said that the '*partial switching*' observed the highest percentage (58.7%), followed by '*no switching*' (24.5%) and '*full switching*' (16.8%). The data reveals that the more than 50% of people in rural Sikkim are partially switch in fuel use. In other words, rural people are dependent on more than two fuels i.e. firewood and LPG. The '*no switching*' i.e. total dependence on firewood use is high. If the percentage of '*no switching*' and '*partial switching*' are analyzed together than the dominance of firewood use would be high; this is a concern area. Whereas, on the other hand, '*full switching*' which represents household consumes only non-solid fuel or LPG has observed low percentage of (16.8%).

It is observed from the field that majority of household wants complete shift to LPG. But factors like economic, physical (infrastructure, environment), LPG distribution system and its frequency/timing has played a determining factor. Therefore, there needs to be an

intervention from the supply side mechanism to make majority of people avail and access clean fuel.

Although the penetration of LPG in rural areas has been slowly improving, there are still efforts need to make for its available and accessible. The dependence on LPG as fuel needs to improve in rural household. Majority of household are dependent on firewood even in those household who has access to LPG. It is primarily due to fuel security and various socio-cultural factors like agriculture, livelihood and socio-cultural practices. However, the fuel security aspect can be counter from the supply side intervention but little can be done in socio-cultural aspects until and unless there is intervention in behavior attributes. Therefore, the study and intervention in the behavior attributes of rural people needs to understand before the policy implementation. This is a big question for social scientists about how to deal with such behavior attributes to make people depend on clean fuel for cooking purposes. The low percentage use of LPG in rural Sikkim is also due to the behavior attributes sans other economic-environmental factors. This can be justifying by observing the percentage use of ‘mixed’ use in rural Sikkim. For instance, despite having LPG connection, rural people are equally dependent on firewood.

3. Intervening factors in accessing household cooking fuels:

The various factors which intervenes the use of various cooking fuels have been captured from the qualitative side. The perspective of responded has been analyzed. However, only the major intervening factors have been highlighted in fuel types (firewood, LPG and mixed). The intervening factors have broadly categorized into three i.e. ‘physical/environment’, ‘economic/political’ and ‘socio-cultural’. Under these broad categories, major factors have been sub-categorized.

Table 6.2: Intervening factors in accessing firewood

Physical & environment		Economic & political		Socio-cultural	
Factors	Percent	Factors	Percent	Factors	Percent
distance, monsoon, scarcity	57.6	Forest rule, deforestation	65.6	inefficient, smoke	52.7
time consuming, tiresome	42.4	hidden cost	34.4	new generation/lifestyle, manpower	47.3
Total	100	Total	100	Total	100

Source: Field survey.

In case of accessing firewood, *'physical/environmental'* factors like *'distance, 'monsoon' and scarcity'* are the major (57.6%) intervening factors along with the others (42.4%) such as *'time consuming' and 'tiresome'*. Likewise, under *'economic/political'* factors, responded respond that *'forest rule, deforestation'* (65.6%) and *'hidden cost'* (34.4%) are the major intervening factors in accessing firewood. The study found that opportunity/hidden cost related to biomass fuel apart from income level is an important determinant of fuel choice; similar result was revealed by Heltberg (2005) in his study.

The factors like *'inefficient', 'smoke' (52.7%) and 'new generation/lifestyle', 'manpower' (47.3%)* are the main intervention in the firewood use under socio-cultural factors. Broadly, the culmination of various factors forces people to discourage the use of firewood as cooking fuel. It is partly also due to the Government of Sikkim's noble policies on environment in general and forest in particular. The lifestyle and the mindset of new generation also have to say about the use of firewood as cooking fuel. Now a days, the young generation have own lifestyle and they considered that the dependence on firewood means the low standard of living or considered themselves as poor which is not 'cool' in their perception. One of the reasons behind such perception among the young generation of Sikkim is that most of them is educated and greatly influence by the 'westernization'; therefore they have developed certain perception on their mind that dependence on firewood for cooking purposes considers as low living standard. The low dependence on firewood is a positive response from the climate change/environment aspect; however, the provision of alternative clean fuels like LPG needs to strengthen in terms of its availability, accessibility, affordability to rural people along with the development of biogas plant for cooking fodder as well as cooking food. The cooking food as well as fodder in biogas plant would be less dangerous than cooking in firewood.

Table 6.3. Intervening factors in accessing kerosene

Physical & environment		Economic & political		Socio-cultural	
Factors	Percent	Factors	Percent	Factors	Percent
inefficient	72	insufficient	43.3	livestock	29.6
smoke	28	irregular distribution system	56.7	time consuming	70.4
Total	100	Total	100	Total	100

Source: Field survey.

In kerosene use, the factors like *'inefficient'* (72%) and *'smoke'* (28%) are the main intervening factors under *'physical/environmental'* category. Likewise, *'insufficient'* (43.3%) and *'irregular distribution system'* (56.7%) are the main factors of intervention under *'economic/political'* category. Under *'socio-cultural'* category, factors like *'livestock'* (29.6%) and *'time consuming'* (70.4%) intervenes in kerosene use as household cooking fuel. Overall, the socio-cultural and physical factors are intervention in kerosene use in Sikkim. In other words, the relevance of kerosene as cooking fuel has substantially low because of its efficiency, pollution and livestock. In addition, the modern families are hardly opting or use kerosene as cooking fuel primarily because of the standard of living. The families now a days is highly westernized in its outlook; with the level of globalization and westernization that are taking place in giving so called *'modern outlook'* which equates as *'standard'* is also one major reason for low kerosene use despite its low cost. Driven by this mindset, the new or young generation people do not want to use kerosene as cooking fuel even if its availability and accessibility is easy. Similar is the case of firewood use but the kerosene use as fuel is substantially low in Sikkim. The government's policy pursuance of kerosene as cooking fuel has lost its relevance even in rural areas. Hence, there should be policy relook and intervention on kerosene so that the subsidy that is in kerosene can divert in other alternative fuels which has its relevance.

Table 6.4: Intervening factors in accessing LPG

Physical & environment		Economic & political		Socio-cultural	
Factors	Percent	Factors	Percent	Factors	Percent
road condition/no road, monsoon	48	hidden cost/high cost, fluctuating price, income	18.8	cultural/tradition/religio N, food habit/taste	34.2
time, distance	52	irregular/no distribution system, documents	81.2	livestock, manpower	65.8
Total	100	Total	100	Total	100

Source: Field survey.

In case of LPG use, *'physical/environment'* factors like road *'condition/no road'*, *'monsoon'* (48%) and *'time, distance'* (52%) are the main response from the responded which intervenes the use of LPG in rural Sikkim. Under the *'economic/political'* category, *'hidden cost/high cost'*, *'fluctuating price'*, *'income'* (18.8%) and *'irregular/no distribution system'*,

'documents' (81.2%) are the major intervening factors in accessing the LPG. Heltberg (2005) also mentioned the opportunity/hidden cost associated in fuel choice. Likewise, under 'socio-cultural category', intervening factors like 'cultural/tradition/religion', 'food habit/taste' (34.2%) and 'livestock', 'manpower' (65.8%) have major role to play. In general, factors like 'irregular/no distribution system', 'documents', 'livestock', 'manpower', 'road condition/no road' and 'monsoon' among the major intervening factors in accessing LPG in rural Sikkim.

In a nutshell, firewood use is mainly intervenes by the strict rule and regulation of the state. The public awareness about deforestation is equally important to discourage the dependent on firewood as fuel along with the other factors like distance, monsoon, scarcity, and lifestyle. While in case of kerosene use, the factors like inefficient and time consuming are the major hindrance for the dependence as cooking fuel. Likewise, socio-economic factors like irregular/no distribution system, documents and livestock and availability of manpower are the major intervening factors in complete dependence on LPG as cooking fuel in rural Sikkim.

Overall, the use of kerosene as a cooking fuel has lost its significance. It would be good if the government relook it and formulate policies which strengthen the policy on LPG in rural Sikkim by diverting the scheme from kerosene. The provision of LPG connection needs to maximize in rural Sikkim along with the provision of biogas plant especially for fodder cooking purpose.

4. Attributes based fuels preferences:

The decision on fuel choice is influenced by various factors besides economic and physical factors. In fact, there are various socio-cultural-economic as well which greatly influence the decision making in choosing the fuel. In other words, the perception on fuel choice varies from one individual to another. Likewise, the decision on fuel choice and their preference also varies based on perception and attributes. It is important to analyze these aspects in social science research. Therefore, the attempts have been made to incorporate these aspects. Here, five attributes have been selected based on "likert scale" method and attempts have been made to rank three fuels viz., 'firewood', 'LPG' and 'kerosene' from 1 to 5 accordingly.

These five attributes are- *Availability, Affordability, Ease of use, Efficiency* and *Pollution*. After that, every household were requested to give ranking based on their perceptions on various fuels. For instance, in firewood (availability), rank 1 denotes that firewood easily available whereas rank 5 denotes ‘difficult’ (refer below table).

Table 6.5: Perception on firewood

Rank	Availability (%)	Affordability (%)	Easy to use (%)	Efficiency (%)	Pollution (%)
1	2.0	12.8	6.0	2.2	0.3
2	22.3	44.5	48.3	28.3	8.2
3	27.7	31.5	33.8	40.2	25.5
4	33.2	9.4	11.4	28.1	38.2
5	14.8	1.8	0.5	1.2	27.8
Total	100.0	100.0	100.0	100.0	100.0

Availability (1=easy, 5=difficult), Affordability (1=easy, 5=difficult), Ease of Use (1=easy, 5=difficult), Efficiency (1=efficient, 5= inefficient), pollution (1=least, 5=most).

In table 6.5, perception has been tabulated on five attributes. In attribute ‘availability’, it is observed that only 2% of household reported that availability is easy whereas 14% reported that it is difficult to avail. Overall, the issue of availability has been the issue because majority of household reported it in the rank of 4 (33.2%), followed by rank 3 (27.7%) and rank 2 (22.3%). In case of ‘affordability’, majority of response was positive which means majority of household responded that they can afford ‘firewood’ and ranked in 2 (44.5%), 3 (31.5%). The percentage of household those find it difficult afford accounts meager 1.8% (in rank 5). In the case of ‘easy to use’ attribute only 6% household responded in rank 1 and majority rank in 2 (48.3%) and 3 (33.8%) which indicated household find easy to use firewood as fuel; the rank 5 accounts only 0.5%. Likewise, the response in ‘efficiency’ attribute also similar picture where majority household ranked in 3 (40.2%), followed by rank 2 (28.3%) and rank 4 (28.1%). On the other hand, rank 1 constitutes only 2.2% which indicates that the problem of ‘efficiency’ is there in firewood use as fuel. In terms of ‘pollution’, the problem of pollution has been observed where firewood poorly ranks in the rank 1 (0.3%) which is least pollution and majority is in rank 4 (38.2%), rank 5 (27.8%) and rank 3 (25.5%). This indicates that majority of respondent respond that that firewood use have pollution problem.

Overall, the attributes like ‘pollution’, ‘availability’, ‘efficiency’ and ‘easy to use’ are the major issue in the firewood use as fuel. However, it is observed that majority of households do not have much issue relating to the ‘affordability’ of firewood. The other factors like availability of other alternative fuels, high opportunity cost in firewood collection, lack of manpower, household occupation, education, environment awareness etc also influence the perception of people.

Table 6.6: Perception on LPG

Rank	Availability (%)	Affordability (%)	Easy to use (%)	Efficiency (%)	Pollution (%)
1	0.8	1.3	56.5	55.2	86.0
2	3.3	17.5	32.3	35.7	10.5
3	16.5	25.8	9.2	7.6	3.2
4	25.2	34.2	1.7	1.2	0.3
5	54.2	21.2	0.3	0.3	0.0
Total	100.0	100.0	100.0	100.0	100.0

Availability (1=easy, 5=difficult), Affordability (1=easy, 5=difficult), Ease of Use (1=easy, 5=difficult), Efficiency (1=efficient, 5= inefficient), pollution (1=least, 5=most).

The perception on LPG as fuel in rural Sikkim highlights that the poor rating in ‘availability’ attribute. In this attribute, only 0.8% household responded with high rank i.e rank 1. The percentage in rank 5 is very high with 54.2%. The percentage is also high in rank 4 (25.2%) and rank 3 (16.5%). This means that it is very difficult to avail the LPG in rural Sikkim. Likewise, the attribute ‘affordability’ is also showing the similar picture with only 1.3% reported in rank 1 whereas 34.2%, 25.8% and 21.2% are in ranked in 4,3 and 5 respectively. Only the meager percentage of household responded that they can easily afford LPG whereas major section finds it difficult to afford. However, the positive aspect is that over 80% household responded that it is easy to use LPG with 56.5% and 32.3% in rank 1 and rank 2 respectively. The percentage of household who responded that it is difficult to use has account only 0.3%. Similar kind of figure has been observed in ‘efficiency’ attribute where 55.2% responded in the rank 1 followed by 35.7% in rank 2, combining two accounts more than 80%. It indicates LPG perceived as the efficient as majority rank in 1 (55.2%) and rank 2 (35.7%) with only 0.3% in rank 5 (inefficient). The same trend has been observed in attribute ‘pollution’ with considerable percentage ranked in rank 1 (86%). On the other hand, rank 4 observed 0.3% and rank 5 observed nil.

Therefore, availability and affordability are the two issues in the LPG fuel use among other attributes. Other attributes like ‘easy to use’, ‘efficiency’ and ‘pollution’ considerably score a positive response for LPG as fuel.

Table 6.7: Perception on Kerosene

Rank	Availability (%)	Affordability (%)	Easy to use (%)	Efficiency (%)	Pollution (%)
1	0.8	12.7	3.7	1.3	0.0
2	1.0	49.7	28.0	15.8	8.2
3	13.8	22.2	55.7	48.7	35.8
4	57.6	15.0	12.0	31.8	49.0
5	26.8	0.4	0.6	2.4	7.0
Total	100.0	100.0	100.0	100.0	100.0

Availability (1=easy, 5=difficult), Affordability (1=easy, 5=difficult), Ease of Use (1=easy, 5=difficult), Efficiency (1=efficient, 5= inefficient), pollution (1=least, 5=most).

It is observed in table 6.7 that the attribute ‘availability’ is poorly ranked in rank 1 and rank 2 with the percentage 0.8% and 1.0% respectively. On the other hand, rank 4 (57.6%) and rank 5 (26.8%) ranked high with combining percentage of more than 80%. By looking attribute ‘affordability’ percentage, there is not such much issue of affording kerosene as majority is in rank 2 (49.7%) and 3 (22.2%) with only 0.4% observed in rank 5 (difficult). However, when it comes to its use, kerosene ranked poorly in rank 1 (3.7%). Observed rank shows that there is response that it is neither so easy nor difficult to use kerosene. Likewise, ‘efficiency’ wise also kerosene has poor perception about its use with only 1.3% in rank 1 and highest in rank 3 (48%). Overall, respond that kerosene has efficiency problem. Similarly, the attribute ‘pollution’ observed same trend rank 1 observed nil. However, the higher percentage is observed in rank 4 (49%) and rank 3 (36%) indicates that the perception of pollution from kerosene use as fuel is high. In five attributes the perception about kerosene use as fuel is negative or poor. Therefore, the low use of kerosene in Sikkim would be because of these perception based response.

Overall, the perception about LPG use as fuel is observed positive response. However, the issue of ‘availability’ and ‘affordability’ is there. On the other hand, the firewood and kerosene use (sole use is nil) as fuel is poorly perceived in Sikkim. Moreover, people have

better perception on LPG as fuel and willing to adopt it; if the issue of availability, accessibility and affordability is addressed.

5. Determinants of LPG: Dependent variable=LPG

The model for logistic regression is given as:

$$\text{Log} \left(\frac{P}{1-P} \right) = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_kX_k + \epsilon_{ij}$$

Where, X_1 and $X_2 \dots X_k$ are 'k' independent variables, the predicted variables have been calculate. Here, the co- efficient is estimated by using maximum likelihood method.

The dependent variable is household depend only on LPG use.

1= yes

0= no

Fifteen predictor variables have been run to see the determinants of LPG use. These variables are:

1. Religion
2. Social category
3. Household income
4. Cultivates agricultural land = Household cultivates agricultural land (last year)
5. Owns livestock = Household owns livestock
6. Banking service = Household have banking service
7. BPL household
8. Awareness about Government schemes
9. Household decision on cooking fuel
10. Education level who cooks
11. Education level of those who takes decision on cooking cooks
12. Awareness about the uses of LPG/induction
13. Distance to travel to get LPG cylinder
14. Conventional use of firewood (religion/cultural significance)
15. Food taste variation if cooked in firewood

Table 6.8: Logistic Regression for using LPG by socio-economic characteristics

Variables in the equation						
	B	S.E.	Wald	df	Sig.	Exp(B)
Religion						
Hindu®			11.290	3	.010	
Buddhism	3.191	1.277	6.249	1	.012	2.325
Christianity	3.496	1.067	10.742	1	.001	3.996
Animism	3.365	1.362	6.105	1	.013	2.942
Social category						
ST®			7.205	3	.066	
SC	.196	1.623	.015	1	.904	1.217
OBC	-2.912	1.591	3.349	1	.067	.054
Others	-1.689	1.305	1.675	1	.196	.185
Household income						
10000 or below®			1.663	2	.435	
10001 - 22000	-1.144	.890	1.651	1	.199	.319
Above 22001	-.564	.667	.714	1	.398	.569
Cultivates agricultural land						
Yes®						
No	-1.853	.753	6.056	1	.014	.157
Owns livestock						
Yes®						
No	-2.661	.612	18.905	1	.000	.070
Banking service						
Yes®						
No	-.259	1.052	.060	1	.806	.772
BPL household						
Yes®						
No	-.357	.626	.325	1	.569	.700
Awareness about Government schemes						
Yes®						
No	.426	.447	.905	1	.341	1.531
Household decision on cooking fuel						
Women®						
Men	1.510	1.122	1.812	1	.178	4.525
Education level who cooks						
Illiterate®			9.715	3	.021	
Primary	-3.770	1.323	8.121	1	.004	.023
Secondary	-2.886	1.013	8.107	1	.004	.056
Higher education	-2.442	.994	6.030	1	.014	.087

Education level of those who takes decision on cooking cooks						
Illiterate®			5.128	3	.163	
Primary	1.960	1.388	1.993	1	.158	2.099
Secondary	2.071	.988	4.388	1	.036	1.929
Higher education	.612	.754	.658	1	.417	1.843
Awareness about the uses of LPG/induction						
Yes®						
No	-2.872	3.554	.653	1	.419	.057
Distance to travel to get LPG						
1 km/ below 1 km®						
Above 1 km	.420	.999	.177	1	.674	1.522
Conventional use of firewood (religion/cultural significance)						
Yes®						
No	-2.915	.969	9.051	1	.003	.054
Food taste variation if cooked in firewood						
Yes®						
No	-1.289	.724	3.175	1	.075	.275
Constant	3.315	4.334	.585	1	.444	27.512
Nagelkerke R square	.774					
-2 Log likelihood	171.174 ^a					

® Reference category

p-value: ***<0.01, **<0.05 and * <0.1

The factors like education (head of household and female), socially marginalized communities like Scheduled Caste (SC)/Scheduled Tribe (ST), household size, location, religion, social groups, credit access are major socio-economic factors which influence various fuel use (Lewis and Pattanayak 2012; Duflo et al 2008; Heltberg 2004; Pandey & Chaubal 2011; Mekonnen & Kohlin, 2009; Rao & Reddy 2006).

In the table 6.8 logistic regression analysis, various socio-economic and physical factors have analyzed. In this regression model, Nagelkerke R square value is (.774) which means that the 77% of model is explained by the selected variables in the model. In religion category, it is observed that as compared to reference category i.e 'Hindu', the other category viz, 'Buddhism', 'Christian' and 'Animism' are coming significant at 90% level of confidence in 'Buddhism' and 'Animism' whereas it is coming 95% level of confidence in 'Christianity'. It reveals that there is high probability of LPG use among 'Buddhism', 'Christianity' and 'Animism' as compared to reference category 'Hindu'. The religion 'Christianity' is most

likely to LPG use among these religion groups with high significance level. The likelihood of LPG use in '*Buddhism*', '*Christianity*' and '*Animism*' is 2.3, 3.9 and 2.9 times higher than the reference category '*Hindu*'. The high likelihood of LPG use among '*Christianity*' embedded in their lifestyle practices. As compared to other religious groups, the '*Christian*' community and their socio-cultural practice is less attached to the conventional practices or rituals associated with forest/environment. Like other religious groups where the firewood use has significance in their socio-cultural life, the Christian household has no such attachment which may have lead to the less dependent on firewood use.

In social category, with reference to ST, the probability of LPG use is (.054) times higher in OBC category with the 90% level of confidence. But, there is no significance of SC and '*Other*' categories. This may be due to the fact that the percentage of firewood use is high among ST population than the other categories. It is because of the socio-cultural practices of ST population are closely associates with forest/environment than the other categories like OBC. They worship nature/environment and their socio-cultural practices require firewood use regularly. For instance, they offer prayers by burning local incense. The percentage of OBC population is high in Sikkim and their livelihood and religious affinity is not associated closely with firewood use like in case of ST population. Similar is for other social groups like SC and '*Other*' category. However, the household income is not coming significant which indicates that more than income there are other factors that are likely to determine the LPG use in Sikkim. Like in other studies by Lewis and Pattanayak (2012); Pandey & Chaubal (2011); Mekonnen & Kohlin, (2009); Rao & Reddy (2006), the SC/ST population are not coming significant which means that the likelihood of LPG use is high in OBC category as compared to reference category ST.

In '*cultivates agricultural land*' category, it is observed that those household which do not cultivates agriculture land last year is (.157) times likely to use LPG than household which cultivates agriculture land. This is due to the livelihood and agricultural practices in rural Sikkim. Such practices provides alternative source of fuel like firewood which is use for both cooking and fodder cooking purposes. Therefore, those households which engage in agricultural practices are less likely to depend solely on LPG for cooking because they needs to look after livestock which is not possible by depending only on LPG. In addition, the

socio-cultural practice of Sikkim is closely link with local deities where the use of firewood has significant role. Therefore, solely dependence on LPG cannot fulfill the social-cultural aspect of Sikkimese people. Similarly, the category '*owns livestock*' is revealing the same picture. As compared to reference category i.e '*owns livestock*' those household which do not possess any livestock is (.070) times likely to use LPG with the high significance level. This further justifies the notion of livelihood/livestock practices and their role in choosing firewood as fuel.

The other factors like '*banking services*', '*BPL household*', '*awareness about government schemes*', '*household decision on cooking fuel*' are not coming significant. It may be due to significant number of household with these services. In addition, there is no so wide variation in accessing these services in Sikkim because there is less differences in urban and rural areas in such services due small size of Sikkim.

In education category, two factors have taken into analysis viz., '*education level of those cooks*' and '*education level of those who takes decision on cooking cooks*'. Under '*education level of those cooks*', those who have education level of '*primary*', '*secondary*' and '*higher education* are' (.023), (.056) and (.087) likely to use LPG than illiterate with significance level of (.004), (.004) and (.014) respectively. In simple term, higher the level of education those usually cooks higher will be the probability of LPG use. This may be due to the engagement of educated people in secondary/tertiary service which left no time to use cooking which is time consuming than the LPG. It is also due to the awareness and benefit of LPG use like indoor air pollution. However in '*education level of those who takes decision on cooking cooks*', only those who have '*secondary*' level of education is coming significant at (.036) and there is there 1.92 times likelihood of LPG use as compared to reference category i.e. '*illiterate*'. Unlike the '*education level of those cooks*', the '*level of education of decision maker on cooking fuel*' have less probability of LPG use because of the direct and indirect association of cooking process between them. Therefore the education of the person who directly engaged in cooking practices has significant role and they are more likelihood to adopt LPG as cooking fuel. This is due to their understanding of difficulties in associated with other fuel use like firewood.

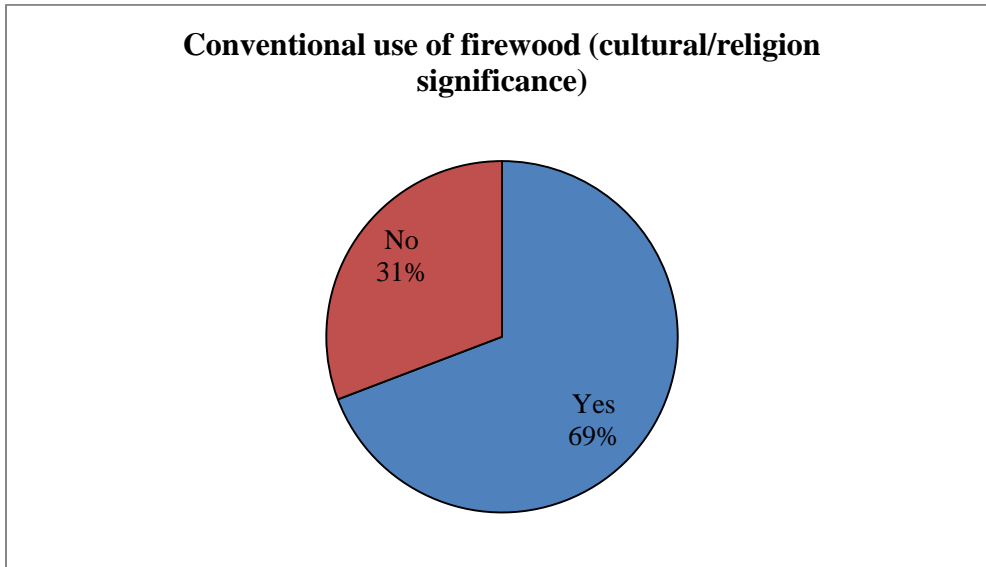
The category like *'awareness about the uses of LPG/induction'* is not coming significant. It is observed from the field survey that majority of the people were aware of the LPG/induction and their use which may be the reason it's insignificant. However, the factors like *'conventional use of firewood (religion/cultural significance)'* and *'food taste variation if cooked in firewood'* are coming significant. It is observed that those household which responded that firewood has no *'conventional use of firewood (religion/cultural significance)'* is more likely to use LPG than those responded that firewood has convention use. There is (.054) likelihood to use LPG who thinks firewood has no conventional use than who thinks that firewood has conventional use. As mention earlier, Sikkimese society and their socio-cultural practices are closely associated with the environment and nature which force people to rely on firewood even they have access to LPG or can afford LPG. Further, those people who responded that there is no conventional use of firewood they are more likely to use LPG in Sikkim.

Similarly, the people who has responded that there is no variation in food taste when it cooked in firewood then they are more likely to depend on LPG. It is observed that those who responded 'no' variation in food if cooked in firewood, the likelihood is (.27) times higher as compared to those who responded 'yes'. Hence proved, that the factors like *'conventional use of firewood (religion/cultural significance)'* and *'food taste variation if cooked in firewood'* has influential role in choosing cooking fuel in rural Sikkim.

6. Behavioral attributes in fuel use:

In most of the research, the behavioral aspects neglect to analyze. In other words, researcher sometimes forgets to see or analyze through the lens of behavior approach. But it is significant to bring the behavior approach in research especially in social science. The behavioral aspects mostly try to analyze the situation from the 'demand side' of the respondent. In other words, the behavior of an individual must incorporate while describing certain social phenomenon. Therefore, it has been tried to understand from the behavior aspect of the people about their perception on using certain fuel. In case of fuel use, despite the government's efforts of providing free and subsidized LPG connection to BPL families the penetration of same is very low. This may be also due to behavioral attributes of people beside other economic-environmental factors.

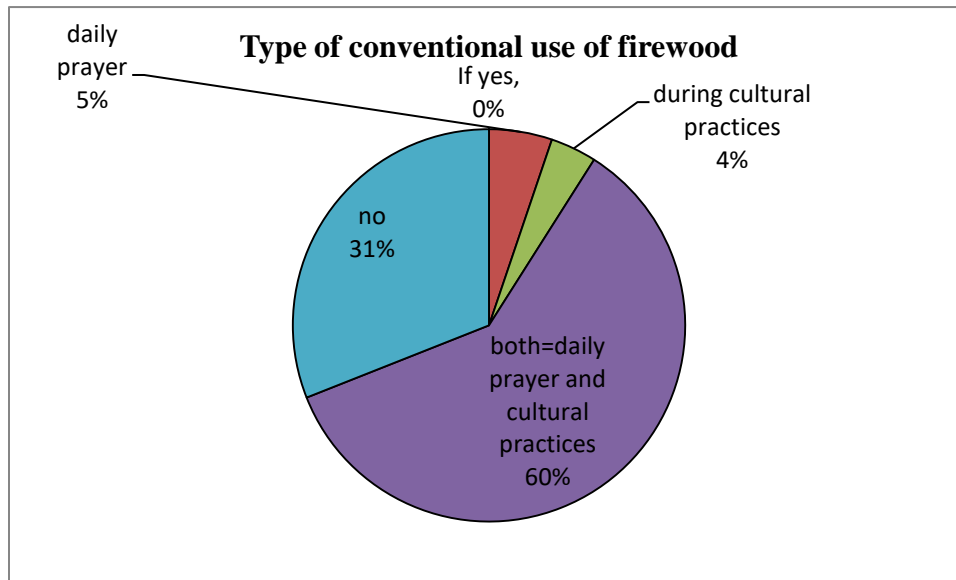
Figure. 6.1: Conventional use of firewood (in percent)



Source: Field survey

In this aspect, the household member were asked about whether firewood have conventional use or not; and then what are the conventional uses of firewood. It is found that majority (69%) of household member responded that firewood have its conventional use while 31% responded firewood has no conventional use. This figure indicates that the rural people have some kind of behavior attachment with the firewood use which is further analyzed in later part (below). The high response of conventional use of firewood may be associated with the behavioral pattern, livelihood, livestock and socio-cultural practices. The conventional use also includes the food taste variation if cooked in firewood. The available literatures (Treiber, Grimsby and Aune 2015) also consider food taste preference as one of the determinants in choosing firewood as fuel especially in tribal and rural areas. This statement further proved from the field survey as most of the surveyed households responded that they have conventional use of firewood and they feel that food cooked in firewood is tastier than in cooking other fuels like LPG.

Figure 6.2: Type of conventional use of firewood



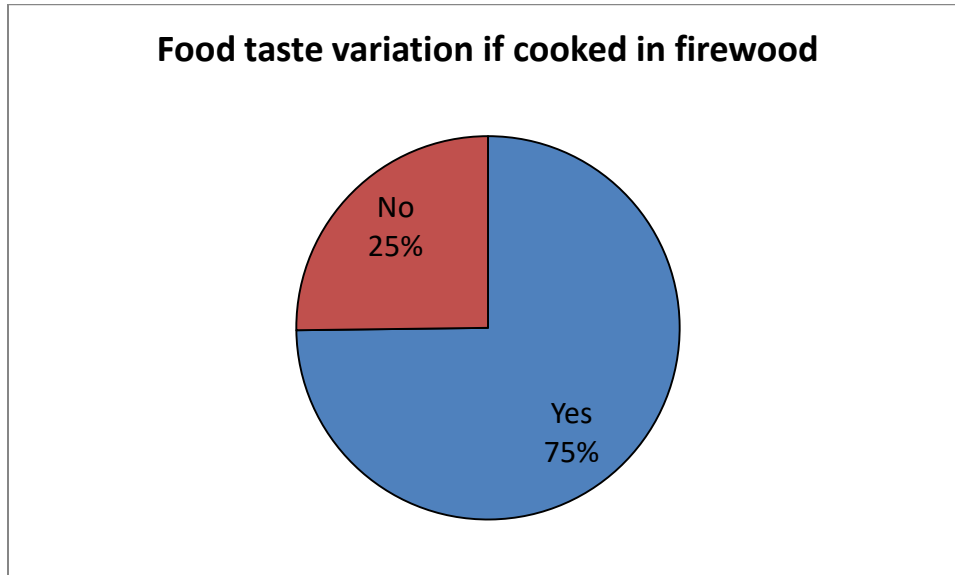
Source: Field survey

The major conventional uses of people were asked. In figure 3 shows that 31% household state that they do not have conventional use while 5% and 4% were reported that they have conventional uses of firewood like *'daily prayer'* and *'during cultural practices'* respectively. However, 60% household responded that firewood has both i.e. *'daily prayer'* and *'during cultural practices'* conventional significance. Therefore, majority of people responded about the conventional use of firewood which is embedded in socio-cultural behavior.

The high percentage of conventional use of firewood is attributed with the socio-ecological setting and the history and cultural aspects associated with them. Sikkim is a hilly state where majority of people resides in rural areas and they mostly practice *'Buddhism'*, *'Animism'* as their religion. The practice of such religion is closely link with the nature/environment where the role of firewood is inevitable in the daily or whenever practiced worship/offerrings to god. For instance, in a Buddhist household firewood is used daily in the morning and evening as they offer prayers by burning incense in fire. Likewise, in a tribal household where the every harvest and sowing season is celebrated as a festival by offering prayers by burning of fire; the use of firewood is inevitable. Even the local priest who usually call *'jakri'* in general and

'phedangba' particularly in *'Limbu/Subba'* culture in Sikkim needs fire while offering mythological local gods of various kinds.

Figure 6.3: Food taste variation (in percent)



Source: Field survey

In another behavior aspect, the question were asked whether the food cooked in firewood taste tastier than cooked in other fuels like LPG. In a response, about 75% stated that 'yes' the food cooked in using firewood as fuel taste tastier than the food cooked in other fuels. It is only 25% responded that they do not find any difference or no taste variation in cooked food whether by using either firewood or LPG. In previous study by Treiber, Grimsby and Aune (2015) also found taste and time are also play an important role in household cooking energy use.

This is the real question to address. The aged old conventional practices rooted in socio-cultural preference on firewood use needs to intervention, so that the rampant firewood can be checked though not completely. Now the question comes what can be done to address such behavior aspect of the people to minimize the firewood use at least. Here, the role of social science can play a vital by creating awareness about the merits and demerits of various fuel uses and its health and environmental implications. This would be the effect way to encourage rural people to depend more on clean fuel use like LPG/indication. Though this process of creating awareness takes considerable time but this would be long term and sustainable implication on the behavior of people. To justify this argument, the failure of

government's effort of subsidized LPG connection is one example. It has been ages that the government of India has taken various initiatives to increase the coverage of clean fuel use especially in rural and poor people but its coverage is still below par despite provision of free and subsidized LPG connection. This would be partly because of the behavior aspect especially in the rural areas where peoples' socio-cultural attributes still important in deciding fuel use. This case is perfectly valid in the study area i.e rural Sikkim where the majority of the people are tribal with rich and diverse socio-cultural linkages. Therefore, failure of the government's initiatives to maximum coverage of clean cooking fuels like LPG is also attribute to the behaviors pattern of the society.

7. Summing up:

In a nutshell, the chapter highlights the intervening factors associated with the use of various fuels. Overall, the problem of availability, accessibility and affordability has been observed in various types of cooking fuel use. Further, the majority of rural people are in "*partial fuel switching*" that is they are using both firewood and LPG in cooking purposes; only 16.8% of rural people of Sikkim are "*full fuel switching*" i.e they are completely dependent on LPG.

In all types of fuel use, the geographical factors like landscape topography, distance, monsoon etc are the major intervening factors for fuel use along with the economic factors like burden of income and opportunity/hidden cost. The other factors like the easy use of fuel and its easy availability, its efficiency and smoke/pollution are some of the factors that matters in choosing fuel types. In socio-economic aspects, the factors like religion, social category, education level, livelihood/livestock, taste preference and conventional use of firewood have been determining the LPG use in rural Sikkim. Further, the behavior aspect of rural people like taste preference, conventional use of firewood have been major factors in the dependence on firewood use. The peoples' capability to afford the clean cooking fuel needs to improve. Despite providing free and subsidized LPG connection/cylinder people are still in position to afford the use it regularly. This is purely because of the capability of people to afford the regular cylinder. This needs thorough evaluation in which 'demand side' can be assess properly before implementing from 'supply side' (government) for the efficient/effective implementation. Otherwise, the implementation process will be as 'business as usual' without any process at ground zero. In addition, the need to incorporate the 'behavior attributes' of the people in the policy framework is also highly felt.

CHAPTER 7:

GENDER AND HEALTH ASPECT IN FUEL USE

1. Introduction:

The term 'gender' has been one of the important aspects in social science research. The sometimes interchangeably use with 'sex', however, the two terms are distinct in nature. Concisely, the term 'gender' is a social construct, in other words, it is the product or creation of society. On the other hand, the term 'sex' is a biological term which is natural. The term 'gender' was not so widely used in earlier studies, however in recent times; it has gain popularity especially in social science research. It tries to study the location of women in the society in relation with their men counterpart unlike 'feminism' which is more women centrist in its approach. It is argued that the men and women play different role in the society which is socially constructed which is influenced by socio-economic factors like historical, religious, ethnic, cultural, ideological, economic etc. In the process of the differentiation of gender role in the society, the position of women directly or indirectly becomes subordinate to men; projects women as dependent and men independent. As stated by Raju (2006), patriarchal ideologies continue to frame the gender issues even if institutional efforts to eliminate the gender differences expand.

In developing countries like India, it can be observe a clear division of labor and the decision making process based on gender. For instance, in a household, man is generally a 'breadwinner' and engaged in productive outdoor activities or public spheres whereas the role of women is private and mostly engaged domestic activities as caretaker of household members and in activities like collection of water/firewood, cooking, child care etc which is non-economical. Due to women's engagement in domestic work they are categorized as 'homemaker'. Moser argued that women have three roles (triple role) viz, "reproductive work, productive work and community managing work".

Reproductive work: It includes but only biological reproduction, childbearing and rearing but also includes maintenance responsibilities of family and reproduction of labor force.

Productive work: It includes the secondary income generation and potential exchange value by women directly or indirectly income engaging in formal or informal (domestic) activities.

Community managing work: It relates to the collective work of women at the community level like role of managing common resource for the benefit of all like water, education, health etc which is unpaid work or non-economical in nature.

The emergence of 'gender' in research or development planning has not been the long time. The realization of women's role in the society in relation with men emerged in 1970s. In other words, this is the major year in which emphasis had given to the role of women in the society. In this context, the work of Ester Boserup was given the credit of bringing the gender prospective in the world scenario. In 1970s, the term "women in development" was coined by the Women's Committee of the Washington, DC, a group of female development professionals who were influenced by the work of Boserup. Later the term 'women in development' was adopted as "women and development" by "United States Agency for International Development (USAID)" with aim to untapped the economic potentials of women in the development process. However, this approach was criticized on the ground that it isolates women in development process. Later, another approach which considers women in relation with men in the development process was adopted. Afterwards, the term "gender and development" was coined by replacing the term 'women' by 'gender' which focused on the social relation of women with their men counterpart in the development process (Moser 1993).

The "United Nations's Decade for Women" (1976-85) had played an important role in highlighting the importance of women in the economic development. In this period, the way women looked in the society had changed like; previously, it was assigned women's role only to household activities, reproductive responsibilities or motherhood etc. However, in this period, the approach started to switch from family-centric, welfare-oriented programmes to the role of women in the production process in development activities. In recent years, the emphasis has been given in the gender planning in every policy/planning. The term 'gender planning' often can be found in social research with its fundamental objective of women emancipation with ultimate long term goal of equality, equity and empowerment. However, in today's world, the gender planning has been facing one fundamental problem i.e its

inability to translate policy into practice. Further, the gender planning practitioner itself lacks formal training in gender discipline unlike other planning like urban planning, transport planning etc (Moser 1993). It is necessary to have formal gender planning training or the indebt knowledge the dynamic of gender and its socio-economic relation while making the gender planning because it has its own specific planning approach with its own planning methodology (Moser 1993). The gender planning needs to have an integrative and comprehensive cross sectoral planning strategy; and upon failing to recognize multiple roles of women may worsen up their condition further.

The need of gender planning is important not only because of varied role of men and women in the society and control over resources but also because of the difference in their needs. In other words, the gender planning emphasized the not only the role of women and men in the society but it also brings the various needs among these binary groups as their role varies according to their position/role and their access to resources in household and society. The difference is not only in accessing the resources among these binary but the differences are also in the resource distribution and management in the household. Interestingly, studies show that the working women have more access or control in resource allocation than the non-working women. However, some researchers argue that there is no clear connection between income and resource utilization. In support of this argument, feminist argues that other factors beside 'income' and women's involvement in the economic activities; 'self-esteem' plays a crucial role in bringing fundamental change (Moser 1993).

2. Indian context:

Indian history shows that the role of women was very limited and restricted in family/household activities. The role of women was confined by the aged old tradition and religious/cultural practices which is still in practice; has put their position low in social hierarchy. The evil practices like sati, child marriage, widowhood were prevalent and there were no choice of freedom/space for women. Later, social reform movements during Indian National Movements tried to eliminate such practices and emphasized on women's education. In post-independence, it is argued that efforts to create spaces for women were made within the socio-economic-political sphere (Raju 2006). The constitution of India also entitled women's right, safeguard and empowerment. However, despite the constitutional

safeguard, the patriarchy in society still exists in Indian society though in lesser degree than earlier days which means that the failure to transform the mindset.

Till mid 1970s, the policies on women were mainly based on welfare and family planning approach. After 1975, the planning and policies toward the women observed a change from 'welfare' to 'development' approach. The decade 1976-85 also celebrated as the United Nations International Decade for Women. In 1975, The Government of India brought a report titled "Towards Equality: Report of the Committee on the Status of Women in India" which focused on gender issues. Later in 1976, the "National Plan of Action" – a report based on previous report came out as major outcome which was based on the UN's "World Plan of Action Women" which highlights the comprehensive women issues. The "United Nations International Decade for Women" made a progressive impact in India started to integrate the women in development process (Raju 2006)

Although much progress has made in recent years on 'women issues' but some household aspects still needs to bring in the development process. For instance, women's activities like the fetching of water, collection of firewood, fodder, and cooking, childcare activities and time spent on such activities needs to integrate in development process. Now, equal treatment and participation of women and men in the development process needs to bring into practice for women empowerment.

India is known for its 'diversity' in physical/geographical and socio-cultural entity with distinct pattern or regionalization. Like that, gender aspect has also its certain geographical pattern in India. As mentioned by Datta, India has categorized into four distinct regions on the basis of gender in India viz, North, South, East and West. The categorization of these regions is based on the basis of observable objects from outside and their explanatory factors incorporating socio-economic values. Datta states that the gender issues in Northern region is dominated by the patriarchy nature, the role of women are restrictive in nature, lower status of women than their men counterpart and the dowry and son preference is prevalent. On the other hand, the gender role in Southern and East India is less restrictive in nature (Datta 2008).

3. Sikkim and its policies towards women empowerment:

Sikkim has some interesting and positive women centric initiatives. In political sphere, women are given 50% reservation; increase from 33% in the past. Likewise, the reservation in jobs, education is equally gender neutral in Sikkim. One interesting scheme in Sikkim formulated by the Government of Sikkim is that if a man marries a differently-able woman then he is awarded some cash. This is a unique scheme which aims to promote right of every women in a society and treat all women with same dignity. There is separate pension scheme for widow along with the old age scheme. Unlike in mainstream Indian societies, the location of women in Sikkimese society has open and less restrictive in nature. Women can roam freely any part of Sikkim anytime without fear of anything. Women have given autonomy and their perspective takes into consideration in decision making process. However, in household activities, women especially in rural areas have responsibility of running household affair like cooking, firewood collection etc. This issue critically highlights the century old socially constructed gender relation in division of labor (SHDR 2014).

As a result of women friendly schemes, women of Sikkim have been venturing every sector equally with men counterpart in recent times even in previously men dominated sectors. For instance, one can find considerable number of women as taxi driver and bus conductor in Sikkim.

4. Socio-economic characteristics and fuel use variation among gender

4.1. Cooking practices among household members

Table. 7.1: Cooking practices among household members (in percent)

		Percent
Sex of the household head	Men	86
	Women	14
	Total	100
Who usually cooks in house	Women	81.7
	Men	2.7
	Both	15.6
	Total	100

Source: Field survey.

Among the total household of 600 household, the men/women headed household observes 86% (516) and 14% (84) respectively. The men headed is significantly high than the women counterpart. The sex of the household head is important in the social science research. It is found that 86% of the household is headed by men whereas only 14% is headed by women. This shows the practice of men domination in the household activities which also exhibits the long practiced of patriarchy or men hierarchy in the society which subordinate women's role. In other words, men have upper hand in handling the major household activities where women's role is limited to other daily household activities like cooking, fetching water and firewood collection. In terms of cooking practices, women are the main to engage. The percentage of women who are engage in cooking practice is high (81.7%) than the men (2.7%) while the engagement by both is 15.7%. This figure reveals that the division of labor in household activities among the gender which is still very much prevalent in Sikkim.

4.2. Firewood collection:

Table. 7.2: Firewood collection (in percent)

Collects firewood in household	Percent
Men	2.4
Women	4.4
Men and women	10
Children	35.2
Labor (khetala in local term - usually collects firewood biannually or yearly)	31.7
NA	16.3
Total	100
Time required to collect firewood (adult) in hours per day	
2 and below	50.8
3	17.8
4 and above	31.4
Total	100
Time required to collect firewood (children) in hours per day	
2 and below	61.2
3	7.8
4 and above	31
Total	100

Source: Field survey.

There is gender issues in firewood collection process where female spend most of time (Hassan M.K, Halder P, Pelkonen P and Pappinen A 2013). It is often require considerable time in firewood collection especially of women and children (World Bank 2003). In other words, firewood collection process women and children tend to spend considerable amount of time than male counterpart (World Bank 2008, 2003). Women especially in rural areas have responsibility of running household affairs like cooking, firewood collection etc (Sikkim HDR 2014).

In the collection of firewood, 35.2% are collected by '*children*' followed by '*other*' (31.7%), '*Not applicable (NA)*' (16.3%), '*men and women*' (10.0%), '*women*' (4.4%) and '*men*' (2.4%). Here, the '*other*' category refers to the labor hire by household to collect or stock firewood for a season or year, it is usually called '*khetala*' (in Sikkim). Likewise, (NA) represents those who are not dependent on firewood or who are exclusively depending on LPG. Children are the main collector of firewood in rural Sikkim. Although they are not engaged in bulky firewood collection but they are constantly engage in firewood collection from surrounding areas like '*bari*' and nearby forest area in school holidays. The '*other*' category has high percentage in firewood collection which includes the labor hire for collection of firewood. This practice is usually practice in once in a year/season and stocks the firewood at least for a season or a year by employing labors. So, this method is most prevalent in rural Sikkim. For adults, time required to collect firewood is mostly '*2 and below hour*' per day (50.8%), followed by '*4 and above hours*' (31.4%) and '*3 hours*' (17.8 %). Likewise, 61.2% of children spend '*2 and below hours*' in firewood collection, '*4 and above hours*' (31%) and '*3 hours*' by 7.8%. In both adult and children, it is observed that '*2 and below hours*' has high percentage. It indicates that the collection field is in nearby areas; it may be '*bari*' (small private surrounding land) or nearby forest area. In case of '*4 and above*', the similar figure in both adult and children indicates that parents takes their children along with them in firewood collection process which is far away from home.

4.3. Exposure to media:

Table. 7.3: Exposure to media (in percent)

Men read newspaper		Women read newspaper	
Regular	6.2	Regular	1.5
Sometimes	30.8	Sometimes	8.5
Never	63	Never	90
Total	100	Total	100
Men watch TV		Women watch TV	
Regular	45.8	Regular	61.4
Sometimes	47.8	Sometimes	34.8
Never	6.4	Never	3.8
Total	100	Total	100

Source: Field survey.

The exposure to media is an important component in social science research. It shows the level of awareness among people. In terms of '*men read newspaper*' it is observed that only 6.2% of men read newspaper regularly whereas majority (63.0%) of men '*never*' reads and 30.8% reads newspaper '*sometimes*'. In terms of '*men watch TV*', there is slight variation in the percentage of '*regular*' (45.8%) and '*sometime*' (47.8%) and the percentage of '*never*' watch is low (6.4%). Similar trend has been observed in women in both '*women read newspaper*', '*women watch TV*'. For instance, only 1.5% of women read newspaper regularly and 90% '*never*' read newspaper while 8.5% read '*sometime*'. However, the percentage of women who watch TV regularly is high (61.4%) and '*sometimes*' and '*never*' observes 34.8% and 3.8% respectively. Overall, men are comparatively better in the exposure to media than the women counterpart which (gap) needs to narrow down.

4.4. Availability of banking and health services in women

Table. 7.4: Availability of banking and health services in women (in percent)

		Percent
Women have banking service	Yes	54.2
	No	45.8
	Total	100
Women have Aadhar card	Yes	97
	No	3
	Total	100
Women have health insurance	Yes	10
	No	90
	Total	100

Source: Field survey.

Now days, the banking service and Aadhar have been important component to get beneficiary of social schemes in India. For instance, to get LPG one has to have banking and Aadhar services. Therefore, it is important to include in the social science research to understand the dynamic. In countries like India it is important have these services accessible to women especially in rural areas. In study area, it is found 54.2% women in the household have banking services and 45.8% do not have. Likewise, 97.0% women in the have Aadhar account and only 3% have no account. Overall, the penetration of banking and Aadhar services in rural Sikkim is good and Aadhar account has been excellent than the banking service. However, women are poorly access to health insurance. It is observed that only 10% of rural women have health insurance leaving 90% without insurance. This is a critical aspect which needs to deal urgently.

4. 5. Household decision making process

Table 7.5: Household decision making process (in percent)

		Percent
Household decision on cooking fuel	Women	90
	Men	10
	Total	100
Household decision on financial affairs	Women	19.8
	Men	80.2
	Total	100
Household decision on health	Women	15.5
	Men	33.2
	Jointly	51.3
	Total	100
Household decision on major purchases	Women	18.8
	Men	31.8
	Jointly	49.4
	Total	100
Household decision on daily needs	Women	71.5
	Men	16.5
	Jointly	12
	Total	100

Source: Field survey.

The household decision making is an important which influence the other activities of household. Generally in India, men are considered as the main decision maker which automatically subordinates the role of women in the society. This is due to the old aged practices of patriarchy. This phenomenon is still deep rooted in our society especially in rural areas where women are not allowed to take participate in decision making bodies.

In that context, it is found that 90.0% of women in the household in rural Sikkim decide on cooking fuel and only 10% by men. However, when it comes to decide on financial affairs only 19.8% are decided by women whereas 80.2% is taken by men which is a huge gender gap. Such gender gap is also visible on health, for instance, only 15.5% of women takes decision whereas 33.2% is by men counterpart and 51.3% by jointly. Similar scenario has been observed in *'household decision on major purchases'* where women accounts 18.8%, men (31.8%) and jointly (49.4%). However, in *'household decision on daily needs'* women accounts high percentage (71.5%) than men (16.5%) and jointly (12%). Overall, it is observed that in main/major decision making process in a household women have low participation, only in minor affairs the participation of women have observed high. Otherwise, in major affairs whether it is financial or major purchase men have the upper hand in decision making process.

4. 6. Women autonomy:

Women autonomy in decision making or resource use is vital for the development. Women's engagement in activities whether it is household or other activities enhances the development process. Women's participation gives different understanding of development process. It is imperative to include women in every development process. Households along with better economic condition and education the empowered of women is one of the factors for clean cooking fuels. In other words, the empowerment of women is more likely to use modern efficient fuel in urban India (Farsi et al 2007).

Table 7.6: Women autonomy (in percent)

		Percent
Women's access to money and autonomy to use	Yes	57.8
	No	42.2
	Total	100
Women's awareness about microfinance	Yes	60.8
	No	39.2
	Total	100
Women who have taken loans from financial institutions	Yes	20.8
	No	79.2
	Total	100
Women can go to the market	Alone	94
	With some else only	6
	Total	100
Women can go the health facilities	Alone	97
	With some else only	3
	Total	100
Women can go to outside village	Alone	90.3
	With some else only	9.3
	Not at all	0.4
	Total	100
Women can go to all places	Alone	72.8
	With some else only	26.8
	Not at all	0.3
	Total	100

Source: Field survey.

It is observed from the study area, 57.8% women responded that they have access to money and autonomy to use and 42.2% responded 'no'. Likewise, in terms of women's awareness about microfinance, it is reported that 60.8% women are aware and 39.2% unaware. Marginally both these aspects give positive meaning as majority of them have access and aware about the microfinance. However, in taking loans from financial institutions, figure show low percentage of women who have taken loans. It shows only 20.8% women have taken loan and 79.2% have never been taken any kind of loan. In case of '*women can go to the market*', figure shows 94.0% women can go alone and 6.0% can go '*with some else only*'. Likewise, 97% '*women can go the health facilities*' alone and 3.0% with '*some else only*'. Similarly, 90.3% '*women can go to outside village*' alone, 9.3% '*with some else only*' and

0.4% 'not at all'. In case of 'women can go to all places', 72.8% women can go to all places, 26.8% 'with some else only' and 0.4% 'not at all'.

Overall, in terms of women's autonomy, there is a positive sign as most of the places women can allow or go alone. It may be due to the space given to women in the society and the existence of peaceful atmosphere in which Sikkim is known for.

5. Media exposure and household cooking fuel use:

Table 7.7: Media exposure and household cooking fuel use (in percent)

		Primary source of fuel for cooking			Chi-square
		Firewood only	LPG only	Mixed (LPG & firewood)	
Sex of the HH head	Men	25.6	15.9	58.5	3.714***
	Women	17.9	22.6	59.5	
	Total	24.5	16.8	58.7	
Who cooks usually	Women	18.4	19.2	62.4	81.243***
	Men	6.2	0	93.8	
	Both	59.6	7.4	33	
	Total	24.5	16.8	58.7	
Men read newspaper	Regular	0	51.4	48.6	91.262***
	Sometimes	7.6	21.6	70.8	
	Never	35.2	11.1	53.7	
	Total	24.5	16.8	58.7	
Women read newspaper	Regular	0	22.2	77.8	34.787***
	Sometimes	5.9	43.1	51	
	Never	26.7	14.3	59.1	
	Total	24.5	16.8	58.7	
Women have bank account	Yes	6.5	26.5	67.1	141.774***
	No	45.8	5.5	48.7	
	Total	24.5	16.8	58.7	
Women have aadhar card	Yes	25.1	16.2	58.8	14.315***
	No	5.6	38.9	55.6	
	Total	24.5	16.8	58.7	

Source: Field survey.

p-value: ***<0.01, **<0.05 and * <0.1

On the basis of 'sex of the household head', it is observed that male headed household has high percentage of 'firewood only' (25.6%) dependent as compared to female headed household (17.9%). Inversely in 'LPG only' use, female headed household has high

percentage of *'LPG only'* use (22.6%) than the male headed household (15.9%). There is marginal difference in *'mixed'* fuel use in male and female headed household but the percentage is high as compared to both *'firewood only'* and *'LPG only'*. In terms of *'who usually cooks'* in household, it is observed that women who cook are mostly use LPG than firewood whereas *'men who cooks'* observed zero percent of *'LPG only'* and *'firewood only'* of 6.2% but observed high percent of *'mixed'* fuel (93.8%). In the household where both men and women engage in cooking observed 59.6% of dependent on *'firewood only'*, 7.4% on *'LPG only'* and 33.0% *'mixed'* on fuel.

Men who read newspaper regularly have high percentage of *'LPG only'* (51.4%) and *'mixed'* fuel (48.6%) use and zero percentage of *'firewood only'* use those who *'read newspaper'* sometimes, the dependence on *'firewood only'*, *'LPG only'* and *'mixed'* are 7.6%, 21.6% and 70.8% respectively. However, those who never read *'newspaper'* have comparatively high percentage of *'firewood only'* use (35.2%) and low percentage of *'LPG fuel'* use (11.1%) than who reads regularly and sometimes. Similar, observation has been observed in *'women who read newspaper'*. Those women who read newspaper regular have high percentage of *'LPG only'* use (22.2%) and zero percent of firewood use where mixed fuel use observe 77.8%. The percentage of *'LPG only'* use is high among those women who read newspaper *'sometimes'* i.e. 43.1%. The *'firewood only'* use is high (26.7%) among those women who never reads newspaper while LPG use is low (14.3%).

Women have bank account have high percentage of *'LPG only'* (26.5%) and low *'firewood only'* use (6.5%). Inversely, women do not have bank account have high percentage (45.8%) and low percentage of LPG (5.5%). However, the use of *'mixed'* fuel is high among both categories. Therefore, it is important to provide banking facilities to women to access clean cooking fuel like LPG. However, there is no such observation in Aadhar case, women who have Aadhar card have percentage of 25.1%, 16.2% and 58.8% for firewood, LPG and *'mixed'* fuel respectively.

6. Decision making and household cooking fuel use

Table 7.8: Decision making and household cooking fuel use (in percent)

		Firewood only	LPG only	mixed (LPG & firewood)	Chi- square
HH decision on financial affairs	Women	20.1	24.4	55.5	6.405***
	Men	25.6	15	59.5	
	Total	24.5	16.8	58.7	
HH decision on major purchase	Women	23	23.9	53.1	6.992***
	Men	28.3	14.7	57.1	
	Jointly	22.6	15.5	61.8	
	Total	24.5	16.8	58.7	
HH decision on daily needs	Women	18.2	21.9	59.9	51.159***
	Men	35.4	5.1	59.6	
	Jointly	47.2	2.8	50	
	Total	24.5	16.8	58.7	
HH decision on cooking fuel	Women	23.5	18.3	58.2	9.589***
	Men	33.3	3.3	63.4	
	Total	24.5	16.8	58.7	

Source: Field survey.

p-value: ***<0.01, **<0.05 and * <0.1

There is slight variation household decision on financial affairs between men and women in *'firewood only'* and *'mixed'* fuel use. However, in LPG use, those women who take decision on financial affairs have high percentage of *'LPG only'* use (24.4%) than those who do not decide (15.0%). Similar is the case with household decision on major purchase where *'LPG only'* is high (23.9%) for those women who take decision themselves than who do not take themselves (14.7%) and both cases *'mixed'* fuel is high. In case of household decision on daily needs, men who take decision have high percent (35.4%) of firewood use than women (18.2%) but *'joint'* decision has high firewood percent (47.2%). In case of LPG use, women who take decision on daily needs have high percentage (21.9%) than the men who take decision (5.1%) and jointly decision observed 2.8%; *'mixed'* fuel is almost similar in both cases.

In case of *'household decision on cooking fuel'*, the high percentage (33.3%) of firewood use is observed in those men who take decision than women (23.5%). However, those household in which women take decision on cooking fuel observe significantly high percentage of LPG

use (18.3%) than the household where men take decision (3.3%). The mixed fuel use in women and men decision makers stands 58.1% and 63.3% respectively.

Overall in household decision making and fuel use, it can be generalized that the higher the percentage of women involvement in decision making, higher will be the use of LPG. This is due to understanding that women have in management of household activities particularly their close associate with cooking practices.

7. Health assessment among children and women:

The health aspect related to burning of cooking fuels is captured with self reported morbidity. This method is adopted from National Family Health Survey (NFHS). The respondents were requested to respond to a set of structured questionnaires related to indoor air pollution due to solid fuel use and its impact on health. In other words, it is symptom based health assessment. Therefore, this study tries to relate the solid fuel use and the health problem symptoms associated with indoor air based on structured questionnaires.

The target groups were identified in study area based on NFHS method. The target groups were children (5 years and below) and their mother; and only those household which is dependent on 'firewood only' or 'mixed' fuel was considered. In survey, 129 children under this criterion were found; and they or their respective mothers were interviewed based on a set of structured questionnaire.

So, on the basis of above mentioned methodology, data was collected. Overall, 129 household were found with children 5 years and below. The six health problems on 'breathing', 'cough', 'wheezing', 'cold', 'fever' and 'poor eye visual' for last 12 days (like in NFHS) were asked for both children and their mother; and the respondents for both questionnaires were mother/father.

7.1. Self reported health attributes in children among firewood user:

Table 7.9: Self reported health problems among children in firewood user (in percent)

Breathing problem	Yes	1.2
	No	98.8
Cough	Yes	11.8
	No	88.2
Wheezing	Yes	13.5
	No	86.5
Cold	Yes	17.2
	No	82.8
Fever	Yes	1.5
	No	98.5
Poor eye visual	Yes	0
	No	100

Source: Field survey.

Based on this criterion, it is observed that 98.8% children do not have any breathing problem; only 1.2% has some breathing problem. Similarly, in other health attributes there is no such health problems are found in children. For instance, in cases like cough (88.2%), wheezing (86.5%), cold (82.8%), fever (98.5%) and there is no case of poor eye sight in children. These figures indicate that there is no such health problem in children related to indoor air pollution. However, the need to study thoroughly with the team of medical and social science researcher is felt to see the cause and effect of solid fuel use and health.

7.2 Self reported health attributes in women among firewood user:

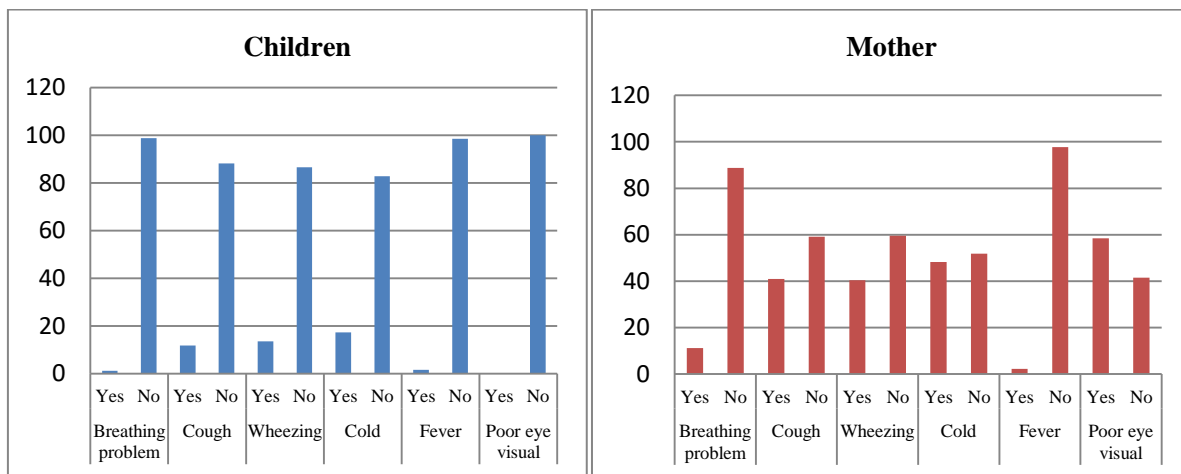
Table 7.10. Self reported health problems among women in firewood user (in percent)

Breathing problem	Yes	11.2
	No	88.8
Cough	Yes	40.9
	No	59.1
Wheezing	Yes	40.4
	No	59.6
Cold	Yes	48.2
	No	51.8
Fever	Yes	2.3
	No	97.7
Poor eye visual	Yes	58.5
	No	41.5

Source: Field survey.

In case of women (mother), the case of breathing problem is reported by 11.2% which is slightly higher in comparison with children; 88.8% reported that they do not have any breathing problem. In case of cough 40.9% reported that they have problem which is high while 59.1% reported 'no'. Likewise, in case of 'wheezing', 40.4% reported 'yes' and 59.6% 'no'. Similarly, in case of 'cold', 48.2% reported that they have cold and 51.8% responded 'no'. In case of 'fever', only 2.3% of women reported they have fever while majority (97.7%) reported 'no'. However, the high percentage (58.5%) of 'poor eye visual' has been reported in women; 41.5% reported 'no'.

Figure7.1: Comparison of self reported health problems among children and mother (in percent)



Source: Field survey

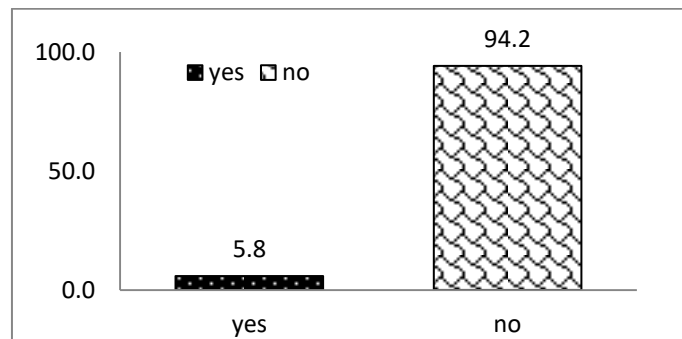
Although more or less similar picture has been observed in both children and their respective mother in case of health attributes related to indoor air pollution, but the degree of prevalence is reported high among women (mother). It is observed from the figure 7.1 that children are fare well in health indicator which is associated with indoor air pollution. In other words, the percentage of health problem associated with indoor air pollution among children is very low. Majority of children were reported to 'no' problem in indoor air pollution indicators which his is a positive sign. On the other hand, their mothers have reported higher degree in the prevalence of health problems associated with indoor air pollution. It is observed that in every high percentage of 'yes' to health problems especially in 'cough', wheezing', 'cold' and 'poor eye sight'.

It would be because of their long associated with the cooking practices but it cannot be said that it is only because of the burning of the firewood. There may be other factors as well which can cause such health problems. This study could not precisely show the relation between firewood use as fuel and health complication on women and children as mentioned in other previous studies like Lewis & Pattanayak (2012); Mekonnen & Kohlin (2009); Pandey & Chaubal (2011); Rehfuss et al (2011); Rehfuss, Mehta, and Pruss-Ustun (2006); Fields (2006); Jain, Choudhary and Ganesan (2015); Edwards and Langpap (2005); Retherford and Smith (2014); Mishra, Smith et al. (2014). Therefore, in this study, the conclusion cannot be drawn that burning of firewood is directly responsible for health problems only on the basis of self reported health assessment. In other words, though, the precise casual effect of indoor air pollution due to firewood use and its impact on health cannot be determine because it is just a self reported and non-medical in nature. The symptoms can be caused by other external factors as well. Therefore, the limitation of such self reported survey is that it cannot say exactly that due to use of ‘such’ fuels it has ‘these’ health implications. However, this can still have its significant source of information for further research.

Hence, there should be long term research in collaboration with medical practitioners and social science to find the precise cause-effect relation of firewood use, indoor air pollution and its impact on health of children and mother. Therefore, in this study, it is simply not possible to see this casual relation considering the time period, the amount of financial expenditure and the requirement of experts from various research backgrounds. However, the future scope of collaborative research to deal this aspect is very much possible.

8. Level of health and other insurance:

Figure. 7.2: Percentage of health insurance

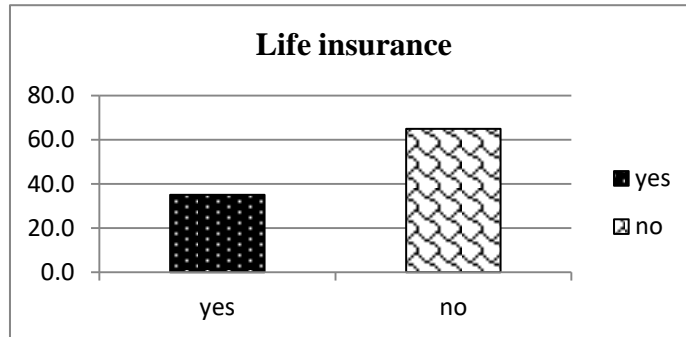


Source: Filed survey

The health is very unpredictable due to which health insurance is important in health emergency. The high percentage of health insurance coverage is good for the human development. Now a days, various private agencies and government sector have come with numerous health insurance schemes in India.

However, in the study area, it is observed that the health insurance coverage is very low. It is found that 94.2% of the household do not have any health insurance; only 5.8% have health insurance coverage. The low health insurance coverage has direct impact on the well being of the people. Although, one private hospital have been providing health insurance to people but it seems its coverage is limited to urban areas only. The Government of Sikkim has announced that the health facilities to rural people are free but in practical the burden of health facilities is high. There should be health insurance coverage to every BPL families from the state government which is feasible due to small population size. It is suggestive that there should be urgent need of health insurance coverage especially to rural people.

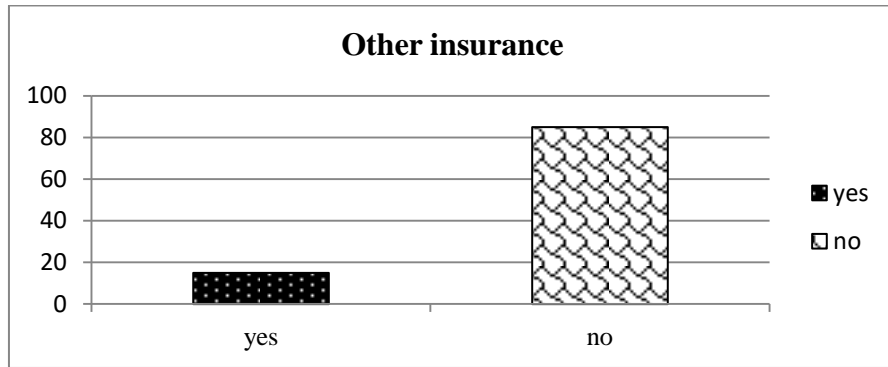
Figure 7.3: Percentage of life insurance



Source: Filed survey

Unlike health insurance, the percentage of life insurance coverage has comparatively better picture. Around 35.1% household have life insurance while 64.9% do not high which is still high. One of the reason of high life insurance coverage than the health insurance scheme may be due to the long history of life insurance scheme in Sikkim. The life insurance scheme has been operating since very long time and majority of people are aware about it even in rural areas. On the health insurance scheme (terminology) is very new to people of Sikkim especially in rural areas and it is recently only health insurance schemes have been coming up. Therefore, due to the history of these two schemes there has been high and low coverage. Life insurance scheme is popular among government employees. One main difference between life insurance is that it can be claim only after the incident or death. However, health insurance can be claim anytime when the insurer get sick. Now, the efforts should be made to insure health of every individual of Sikkim especially in rural areas which can be claim anytime and anywhere. In rural areas, its implementation process needs to efficient and effective as the rural people have risk to various health risks. In doing so, every member of the household is eligible for health facilities including children.

Fig. 7.4: Percentage of Other insurance



Source: Filed survey

‘Other’ insurance includes house insurance, vehicle insurance, property insurance etc. There is low percentage of ‘other insurance’; it may be due to low possession of such property. But, it is surprising to observe that among the three forms of insurance; the percentage coverage of health insurance is the lowest. This is a cause of concern. This is due to the lack of awareness about health insurance and its importance especially among the rural people which needs to be dealt urgently. The health insurance coverage should be the priority in rural areas due to the health risks that people are exposed to.

The health insurance is an important component of public health concern now a day. The study area observed a low percentage (5.8%) of households having health insurance whereas 94.2% of households do not have health insurance. The low health coverage is a big concern in Sikkim. However, the life insurance coverage is comparatively better than health insurance with 35.1% of households having life insurance cover while 64.9% do not have (which is still a high percentage). Similarly, the percentage of ‘other insurance’ cover is similar or high, like 85.0% of households do not have any kind of insurance and only 15.0% of households have some kind of insurance which needs to be improved.

9. Summing up:

The inclusion of ‘gender’ in social science is an important approach to understand the social structure and its influence on development aspects. The study of gender dynamics is complex which requires understanding of society and their structure/hierarchy and the location of women and men in a society. The differentiation in the location of men and women in a society and the differentiation in their treatment influence the development dynamics. In turn,

the development outcome varies accordingly as per gender roles in a society. In India, like diverse physical features, societies are also diverse in nature where the gender role varies within and across societies. Some societies give greater autonomy/freedom and some have restrictive in nature. When we talk about the gender, the concept like women autonomy/empowerment/freedom comes automatically. Therefore, it is sometimes 'gender' lens interchangeably use as women autonomy/empowerment/freedom in a society. In developing countries like India, the location of women in a society is restrictive in nature, sometimes they are assigned for household activities like cooking, collection of water/firewood, taking care of children/husband/elderly which is rooted in old age practice of patriarchy. In can be still fair to say that Indian societies are still patriarchy in nature or male dominated though its degree has been decreasing comparatively over the years. The study area i.e rural Sikkim also shows the gender issues in relation to household activities. For instance, the most of the household is headed by men (86.0%); only few household is headed by female. Likewise, in cooking practices also there is wide difference; around 81.7% cooking is done by women. In firewood collection process also the percentage of women is comparatively higher than men. In terms of exposure to media also women have low percentage. The health insurance coverage among women is considerably low; only 10% have health insurance. In household decision making process also men have upper hand in most of the cases than the women counterpart. However, in terms of 'women autonomy', the percentage is quite impressive.

The role in the household cooking fuel has been analyzed and it is found there are differences in most of the household variables which is attributed due to way of life and livestock practice in rural Sikkim. The variation in role of men and women in the study cannot be simply attributed to the patriarchy. It is more attributed to the lifestyle practices, livelihood and livestock etc. For instance, division of labor in outdoor and indoor activities; men tend to engage more in outdoor activities which is physically demanding while women in indoor which is less physical. Therefore, it would be wrong to single out the gender discrimination simply because of the division of labor. It can be contextualize from the geo-physical requirement in the region rather than putting in the existence of patriarchy in the society. Although it cannot be said that there is no patriarchy in Sikkimese society but its degree is significantly low.

CHAPTER 8

POLICY SUGGESTIONS ON FUEL USE

1. International scenario:

Over the years, the global community has constantly formulating various plans/policies and programmes to curb the global challenges like climate change, global warming and environment degradation. These global challenges are basically due to the combining forces of industrialization, spurt population growth and rampant extraction of natural resources. The terms like climate change, global warming and environment degradation has been the pressing issues to deal at every level. The adverse effects of such challenges have local, regional, national and international implications which make our planet earth inhabitable.

The initiative to deal with such issues came up in 1980s when the global communities started to have realization that something needs to be done to curb the global warming, climate change and environment degradation. Some of the attempts made by scientific communities to deal such issues in the past are as below:

Table. 8.1: Some of the major initiatives to deal with climate change issues

Nov-1988	IPCC Established	“World Meteorological Organization (WMO)” and “UN Environment Programme (UNEP)” established the Intergovernmental Panel on Climate Change IPCC. To this day IPCC assessments are the scientific underpinning of international negotiations while also providing unique insights into
Jun-1992	UNFCCC Opens for Signature at Rio Earth Summit	The “United Nations Framework Convention on Climate Change” opens for signature at the Earth Summit in Rio, bringing the world together to curb greenhouse gas emissions and adapt to climate change. The UNFCCC has two sister Conventions also agreed in Rio, the “UN Convention on Biological Diversity and the Convention to Combat Desertification”.
11-Dec-1997	Kyoto Protocol Adopted	The third Conference of the Parties achieves an historical milestone with adoption of the Kyoto Protocol, the world's first greenhouse gas emissions reduction treaty.
16-Feb 2005	Kyoto Protocol Enters into Force	History is made when the Russian Federation submitted its instrument of ratification to the Kyoto Protocol, sealing its entry into force.
Jan-06	Clean Development Mechanism Opens	The “Clean Development Mechanism”, a key mechanism under the Kyoto Protocol, opens for business.
Dec-2007	Bali	The thirteenth Conference of the Parties adopts the Bali Road Map, including the Bali Action Plan, charting the course for a new negotiating process to

		address climate change. The Plan has five main categories: shared vision, mitigation, adaptation, technology and financing.
Dec-2009	Copenhagen	World leaders gather for the fifteenth Conference of the Parties in Copenhagen, Denmark, which produced the Copenhagen Accord. Developed countries pledge up to USD 30 billion in fast-start finance for the period 2010-2012.
Dec-2010	Cancun	The sixteenth “Conference of the Parties results in the Cancun Agreements”, a comprehensive package by governments to assist developing nations in dealing with climate change. The “Green Climate Fund”, the “Technology Mechanism and the Cancun Adaptation Framework” are established.
Dec-2015	COP 21 - Historical Paris Agreement adopted	195 nations agreed to combat climate change and unleash actions and investment towards a low-carbon, resilient and sustainable future, on 12 December 2015.
		The Paris Agreement for the first time brings all nations into a common cause based on their historic, current and future responsibilities.

Source: UNFCCC -- 20 Years of Effort and Achievement Key Milestones in the Evolution of International Climate Policy. <http://unfccc.int/timeline/>

In 2015, UN adopted “Sustainable Development Goals (SDGs)” by replacing “Millennium Development Goals (MDGs)” which have 17 goal and covers wide range of development aspects which is set to achieve its target in the year 2030. Following are the 17 Sustainable Development Goals:

Table. 8.2: Sustainable Development Goals

1. No Poverty	10. Reduced inequalities
2. Zero hunger	11. Sustainable cities and communities
3. Good health and well-being	12. Responsible consumption and production
4. Quality education	13. Climate action
5. Gender equality	14. Life below water
6. Clean water and sanitation	15. Life on land
7. Affordable and clean energy	16. Peace, justice and strong institutions
8. Decent work and economic growth	17. Partnership for the goals
9. Industry, innovation and infrastructure	

Source: <https://www.un.org/sustainabledevelopment/>

Among these, the goal number 7 deals with ‘ensure access to affordable, reliable, sustainable and modern energy for all’. The access to energy is essential to all the major challenges issues like climate change, inclusive and sustainable development. It is estimated that 3 billion (approximately) people lacks access to clean-cooking solutions and exposed to indoor air pollution; and around 1 billion people are having no access to electricity for lightening and 50% of them are found in Sub-Saharan Africa. Therefore, access to clean energy,

whether it is commercial or household level is need of the hour for the sustainable development.²⁰

Table 8.3: Facts and figures

13% of the global population still lacks access to modern electricity.
3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating
Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas emissions.
Indoor air pollution from using combustible fuels for household energy caused 4.3 million deaths in 2012, with women and girls accounting for 6 out of every 10 of these.
The share of renewable energy in final energy consumption has reached 17.5% in 2015.

Source: Sustainable Development Goals.

According to WHO, an estimated 4.3 million people a year dies from the exposure to household air pollution which results pollutants like particulate matter (PM), methane, carbon monoxide, among others which are health damaging substances; because the indoor air pollution is considered as more harmful than outdoor pollution due to closed areas (NITI Aayog, Breath: India- An Action Plan for Combating Air Pollution). Exposure to combustion and outdoor/indoor air pollution, tobacco smoke causes diseases like pneumonia in young children and chronic lung disease, heart disease, stroke and lung cancer in adults. Although there are other factors as well for these diseases but it is considered that substantial amount is caused by the use of solid fuels as cooking fuel in India (Kirk R Smith, 2016)²¹.

2. Indian scenario:

It is estimated that an around 500 million Indians are dependent on solid biomass for cooking and around 304 million Indians do not have access to electricity (India: Tree Year Action Agenda, NITI Aayog 2017). According to FSI (2011), more than 853 million people dependent on firewood as cooking fuel in India. As per Census of India, 2011 around 49% of Indian population is depended on firewood as cooking fuels. Estimates suggest that India alone is home to about 830 million people who still rely on traditional biomass to meet their cooking energy needs (IEA 2015; Gould et al. 2018; WHO 2018). The dependence on traditional fuels affects families' health and safety. Every year in India, the indoor air

²⁰ <https://www.un.org/sustainabledevelopment/energy/>.

²¹ <https://www.financialexpress.com/economy/lpg-scheme-is-historic-opportunity-to-improve-households-health-kirk-r-smith/244299/>

pollution is caused mainly by burning traditional biomass which leads to an estimated 1.24 million premature deaths (WHO 2018).

The history of providing clean cooking dates back in early 1970s when the Government of India had attempted initiatives by promoting various fuels and technologies. From the beginning, the Government of India started to provide LPG at subsidized prices. Since the 1980s, the government has also introduced various policies to promote biomass cook stoves like the “National Programme on Improved Cookstoves”²² (1983), the “National Biomass Cookstoves Initiatives”²³ in 2009 and “Unnat Chulha Abhiyan”²⁴ in 2013 and for biogas like “National Project on Biogas Development” in 1981-82, the “National Biogas and Manure Management Programme” in 2002-03, and “New National Biogas and Organic Manure Programme” in 2018. However, the adoption of non-LPG cooking energy solutions has been very limited owing to disproportionately low budgetary support, poor management of technology, deficient after-sales services, and limited suitability for users and low levels of awareness.

Lately, the Government of India has initiated some major policy to avail clean cooking fuels. For instance, the “Direct Benefit Transfer of LPG (DBTL)” scheme in 2014-15 also called “Pratyaksha Hastaantarit Laabh (PAHAL)” programme which gives directly transferred to the bank account of the consumer, the “Give-It-Up” campaign in 2015 to rationalize subsidies and the “Pradhan Mantri Ujjwala Yojana (PMUY)” in 2016 which aimed to provide free LPG connections to below poverty line (BPL) households (also to disadvantaged groups) to 50 million which expanded to 80 million to socio-economically weaker households are landmark decisions. The “Direct Benefit Transfer of LPG (DBTL)” scheme in 2014-15 programme results more than 12 crore connections linked to bank accounts within 15 months. Till November 2018, 57 million connections with the overall target has enhanced

²² The Government of India’s introduced National Program of Improved Cookstoves in 1983 as a demonstration program some 33 million biomass-based improved stoves in rural areas during 1984-2000.

²³ The National Biomass Cookstoves Initiative (NCI) was launched by the Government of India in 2009 to extend the use of clean energy to all of India's households by providing cookstoves, biomass-processing technologies and deployment models” (MNRE 2009)

²⁴ Aims to provide cleaner cooking energy solutions in rural, semi - urban and urban areas using biomass as fuel for cooking

to 80 million connections by 2020. This LPG scheme is considered as the historic opportunity to improve households' health²⁵.

The India's policy on LPG has been fluctuating in nature. In 2012, the Government of India's policy to restrict six cylinders to a household in a year had to revise to twelve cylinders per household per year. Before that, there was no such limitation. On 1 June 2013, the Government of India again introduced cash-transfer scheme known as the "Direct Benefit Transfer Scheme for LPG" (DBTL scheme), a conditional cash-transfer scheme where the efficiency of delivery system and check in black market of cylinder were the main motive so that targeted section of society get the beneficiary. It is a noble step especially toward the weaker section of the society. However, the schemes have faced some criticism from experts like it was mandatory to have Aadhar card linked with the bank account to get this scheme which was not possible in a short period of time due to bureaucratic and other social interventions. Therefore, the scheme had to halt in 2014 and again the revised scheme was launched as "PAHAL" in November 2014. At first, it was launched only in 54 districts later on it implemented throughout the country in January 2015. This revised scheme i.e "PAHAL" was basically launched with following main aims viz. (1) improvement in the of LPG delivery system 2. Subsidized cylinder reaches to the entitled consumer (2) check in the unauthorized diversion or duplicate connections (Jain, Agrawal and Ganesan).

The LPG adoption has increased gradually in the country over the years. However, there is wide disparity between urban and rural populations in terms of access. In spite of government's efforts, the large section of population are still depended on traditional biomass for cooking due to the high recurring (affordability and accessibility) cost of LPG and the availability of free biomass despite having LPG connections.

In terms of electricity, the government in 2015 had launched a programme named "Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)" by superseding previous programme "Rajiv Gandhi Gramin Vidyutikaran Yojana (RGGVY)" with aim to provide 100% village electrification within 1,000 days in particular and improve electricity access in general. In addition, the government has announced another ambitious programme named "Pradhan

²⁵ <https://www.financialexpress.com/economy/lpg-scheme-is-historic-opportunity-to-improve-households-health-kirk-r-smith/244299/>

Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)” in October 2017 with a target of 100% household electrification by March 2019. Therefore, the programmes like “PMUY” and “Saubhagya” have visions to provide electricity and clean cooking energy connection for every household in the country.

3. Sikkim: Policies on energy sector:

“Sikkim Renewable Energy Development Agency (SREDA)”: The “Sikkim Renewable Energy Development Agency (SREDA)” was constituted by the Government of Sikkim in 1999. This body entrusted the “task of promoting and popularizing renewable energy and to act as the State Nodal Agency for all renewable energy programmes and projects in the State”²⁶.

Briefly, the objectives of the agency are:-

- National Biogas & Manure Management Programme
- Solar Photovoltaic Programme (SPV)
- Solar Power Plants
- Solar Water Heater
- Energy Parks
- Wind Energy
- Micro Hydel
- Publicity & Awareness
- Green Building Conference

“National Biogas and Manure Management Programme (NBMMP)” in Sikkim:

The “National Biogas and Manure Management Programme (NBMMP)” was started in 2014. The objective of (NBMMP) was to provide fuel for cooking purposes and organic manure to rural households by constructing biogas plants. In Sikkim, under “NBMMP”, family size biogas plants 2 cubic meters are constructed. The cost of constructing one biogas unit is Rs.22,000/- out of which Rs.17,000/- is met from Central Financial Assistance(CFA) from the “NBMMP” programme, Rs.5000/-from State Plan provisions. Beneficiaries for this

²⁶ <http://www.sreda.gov.in/>

programme are selected through the recommendations of the Panchayats and after verification of criterion as envisaged in the NBMMP Programme guidelines. The programme has found wide acceptability amongst rural farmers as an affordable means of cooking and lighting alternative source of energy (SREDA 2014).

Biogas plant:

Financial Year 2011-12

- For the financial year 2011-12, 2 cu.m of 300 numbers of family size biogas plants were targeted and achieved 221 numbers of biogas plants.

Financial Year 2012-13

For the financial year 2012-13, 200 nos of family size biogas plants were proposed and wherein 170 numbers of biogas plants were installed by 30th March 2013 in all four districts of Sikkim.

In Sikkim, under NBMMP there is a provision of construction of biogas plants to the rural people and the process of selecting beneficiary is in the hands of local governance i.e Panchayat. Interestingly, in government documents it is found that there is sizeable number of biogas plant construction. Surprisingly, in the field study, it is found that not a single household has been using bio gas plant for cooking purposes; even if a household have biogas plant their use is obsolete or limited. Although the (NBMMP) programme is there but their success rate at ground is minimal; which needs to push up in rampant way. Therefore, it is suggestive to all the stakeholders who all are associated with policy making or implementing on biogas plants there should be urgent policy relook as the existing policy is obsolete. In reality the implementation of biogas plants and its usage are very low. The policy advice is to officials –strengthen the existing system of biogas plant and focus should be on understanding of the demand side factors like why there is low usage of biogas plants and what the factors responsible for it. In addition, there should be some kind of initiatives to those household who are using biogas in regular manner; there should be regularly update about its implementation and usages.

4. Primary source of fuel for cooking:

Table 8.4: Percentage of household cooking fuel use in Sikkim

Sikkim	Firewood (%)	LPG (%)	Mixed (LPG & firewood) (%)	Total Sample Household
	147 (24.5)	101 (16.8)	352 (58.7)	600

Source: Field survey

There are three type of cooking fuel use in Sikkim viz., firewood, LPG and ‘mixed’. Other cooking fuels like biogas, coal/charcoal, cow dung, electricity are virtually absent. The ‘mixed’ fuel use is most prominent in rural Sikkim constituting 58.7%. However, the percentage of clean fuel use i.e LPG is low (16.8%) while firewood constitutes 24.5%. Among the source of lightening, electricity is the main source in Sikkim.

5. A supply-demand nexus in rural Sikkim:

The demand-supply nexus is important to understand the ground reality which greatly influences the implementation of social schemes like LPG. Here, the demand sides have been looked from the awareness and public participation. On the supply side, road accessibility and its usability during monsoon season, banking facilities and provision of PDS have taken into consideration.

Table 8.5: Demand side (in percent)

		Percent
Awareness about Govt. schemes	Yes	26.5
	No	73.5
	Total	100
Attend public meeting	Regular	29
	Sometimes	64.2
	Never	6.8
	Total	100
Awareness about LPG/Induction	Yes	99
	No	1
	Total	100

Source: Field survey

In social science research, ‘awareness’ is considered as an important factor for analysis. Awareness is positively correlates with the development aspect. Taking this aspect, the

awareness about government schemes is considered in this study. It is observed that 73.5% of the household do not have awareness about the government schemes, only 26.5% households are aware. This is one of the reasons which constrain in accessing development schemes like LPG. There is an urgent need to create awareness among the rural people about the government schemes. One way to create awareness about the government schemes is public meeting where various socio-development issues will put into discussion. In this aspect, rural Sikkim poorly fairs as only 29% of household responded that they are attending public meeting regularly. Large chunk of household attend public meeting ‘sometimes’ only (64.2%) while 6.8% responded ‘never’ attends public meeting. However, the awareness about the LPG/ induction is high in rural Sikkim which is a good sign. It is observed 99% household responded that they are aware about LPG/induction and their use. Now, the question is even after being aware about LPG/induction; people are still unable to access it in large. Therefore, it raises the question on peoples’ capability aspect which may due to income, socio-environmental and supply side mechanism.

Table 8.6: Supply side (in percent)

		Percent
House accessibility by road	Pucca road	20
	Kachha road	10.2
	Footpath	69.8
	Total	100
Road useable during monsoon	Yes	69.2
	No	30.8
	Total	100
HH banking	Yes	82.8
	No	17.2
	Total	100
Schemes from PDS (getting)	Yes	48.3
	No	51.7
	Total	100

Source: Field survey

The rural Sikkim has some issues from the supply side. For instance, there is only 20% of house which is accessible by road while majority (69%) is access by ‘footpath’ and 10.2% by ‘*kuchha*’ road. However, 69.2% responded that these roads are usable during monsoon period and 30.8% responded that the roads are unusable during monsoon. Other supply

factors like ‘banking’ facility have observed 82.8% while only 17% have no banking facilities. The percentage of household that are getting schemes from PDS is reported 48.3% while 51.7% responded that they are not receiving. The comparatively low percentage of getting schemes through PDS may also attributes to respondents’ lack of awareness about PDS.

The factors like usability of roads during monsoon and banking facilities is not so big problem, however, the connectivity in rural Sikkim with all weathered roads (pucca road) is felt which is important in rural development process.

6. Firewood:

Sikkim has total geographical area of 7096 sq km- is the second smallest state in terms of area, and contributes 0.22% of the country’s geographical area. Sikkim has 75.85% land under *forest area*²⁷. As far as total *forest cover*²⁸ is concern, 47.13% (3344 sq km) is under state’s geographical within which 93% is reserve forest and 6.6% is under protected forest. Further, Sikkim is also home to a national park and seven wildlife sanctuaries having total area of 2,179 sq. km (31% of state geographic area) (SHDR 2014; State Human Development Report 2014). Sikkim has high percentage of forest area and rich in biodiversity. Two important factors contributes for such rich forest resource in Sikkim, firstly, due to the location of the state in the eastern Himalaya – which is embedded with rich natural environment and secondly, due to the pro-forest/environment policies of the state government. The rules and regulations for forest conservation measures are strict in Sikkim. The felling of trees and export of timbers is strictly banned in Sikkim. Even to fell the private tree, one need to take permission from forest department; only dead and dying trees are allowed to cut down with prior permission (Tambe and Arrawatia 2012). Because of such pro environment policies, the area under dense forests in Sikkim have slightly declined during the period 2001 to 2003 but increased again from 2003 onwards (Forest Survey of India 2013). The area under scrub vegetation also increases from 2001 onwards but it is observed to decrease from 2005 onwards (Ravindranath, Sharma, Sagadevan, Jayaraman, Munsii

²⁷The term forest area or Recorded Forest Area refers to all the geographic areas recorded as ‘Forest’ in government records.

²⁸ The term ‘Forest Cover’ refers to all lands more than one hectare in area with a tree canopy of more than 10%, irrespective of land use, ownership and legal status.

2012). As per Forest Survey of India (2013), among North eastern state Sikkim is the only state that has been able to keep its forest cover intact since 2009 and Sikkim has also recorded zero net loss of forest cover in all districts. Since 1995, Sikkim has been actively introducing numerous policies on forest to for its healthy growth.

Forest plays an important role in carbon sequestration or carbon stock. Forest is considered as the largest terrestrial ecosystem for carbon sequestration which helps to mitigate the climate change. As per the state of forest report 2017, Sikkim has total carbon stock of forests in the state is 48.534 million (177.958 million tones of CO₂ equivalent) which is 0.69 % of total forest carbon of the country²⁹. It is found that burning of biomass has great implication on climate change as it releases black carbon (soot). It is the residual part of biomass fuel results from the incomplete combustion process (Ramanathan and Carmichael 2008). Black carbon is the major contributor to climate change and traditional household cooking energy use is the significant source of black carbon (Bond et al 2004).

As majority of people in Sikkim resides in rural areas, the increasing population has put pressure on resource like fuel wood, fodder and timber, besides land for agriculture. Forest is an important source of livelihood and ecological security in rural Sikkim. Dependence on firewood as fuel is high in Sikkim where on an average a household needs around 7,400 kg fuel woods every year. Around 80% of firewood demand is met from reserve forests and around 19% is from private forest. It is estimated that average fuel wood consumption for a household is over 20 kg per day where its requirement varies seasonally for example, daily household usage peaks in winter at 25 kg. The tourism sector especially eco-tourism and trekking has been flourish in Sikkim, resulting high demand of firewood. The fodder collection from forest is also practiced in Sikkim. Children and women are chief firewood collector in Sikkim and this collection process is mostly carried out in winter season. The reason behind the engagement of children in firewood collection process may be the timing of winter school vacation.

²⁹ <http://fsi.nic.in/isfr2017/sikkim-isfr-2017.pdf> or State of Forest Report 2017, forest survey of India, Ministry of Environment and Forests, GOI

Table. 8.7: Forest Products Collected by Respondents for Own Consumption (in percent)

Districts	Fuel wood	Litter/leaves	Fodder	Wild edibles	Bamboo stems	Medicinal plants/herbs	Bamboo shoots	Others
EAST	88	73	81	54	81	54	46	0
NORTH	92	79	71	100	38	54	25	40
SOUTH	97	97	90	68	81	71	81	30
WEST	97	89	89	68	76	59	43	0
ALL	97	86	84	71	70	60	50	20

Source: Sikkim Human Development Report, 2014.

The above table 8.7 shows that the fuel hood/firewood is the main forest products that people are dependent. It shows that the high percentage of fuel hood is used in South (97%) and West district (97%). However, the fuel hood is low in East district among the four districts of Sikkim. Other forest products like litter/leaves, fodder, wild edibles, bamboo stems are also derived from the forest.

Table 8.8: Trends in forest cover at district-level (sq. km.)

	Total forest	Total forest	Change
DISTRICTS	2005	2007	2005-07
East	679	699	20
North	1326	1315	-11
South	529	571	42
West	728	772	44

Source: Ravindranath, Sharma, Sagadevan, Jayaraman, Munsii, 2012.

Table.8.9: District wise forest cover (area in sq km)

District	Geographical area	2017 Assessment				% of Geographical Area	Change *
		Very dense	Moderate dense forest	Open forest	Total		
East District	954	266	319	128	713	74.74	14
North District	4226	398	600	287	1285	30.41	-31
South District	750	172	291	109	572	76.27	3
West District	1166	245	365	164	774	66.38	5
Grand total	7096	1081	1575	688	3344	47.13	-9

*change compared to updated 2015 assessment

In a study carried out by the Ravindranath, Sharma, Sagadevan, Jayaraman, Munsri in 2012, the change of total forest in between 2005-2007 is highlighted. It can be observe from the table (8.9) that except North district all other district observed slight increase in forest area. North district has observed negative growth of (-11 sq km) in its forest area. Similar, picture reveals in the state of forest report 2017, where North district observed loss of 31 sq km of forest area in the period 2015-2017. Interestingly, State of Forest Report 2017 also observed total 9 sq km loss of forest cover for the whole Sikkim. The loss of forest cover and forest area in Sikkim needs to check soon which not a good sign for the overall sustainable development. The reason for such negative growth would be attributed to the sudden surge in the development activities like hydropower projects, pharmaceutical companies in the state.

7. Joint Forest Management (JFM):

In 2002, state government formed the “Joint Forest Management Committees (JFMC)”, 49 “Eco development Committees (EDC)” and 7 Forest Development Agencies for the effective management and conservation of forest area of Sikkim. Sikkim’s 84% of the total geographical area is forest land under the jurisdiction of the Forests, Environment & Wildlife Management Department, Government of Sikkim. There are a total of 907 villages (Gram Panchayat Wards) in the state and because of the large extent of forests; every village is a fringe forest village with Khasmahal, Goucharan and Reserve Forests. Therefore, the state government has taken a decision to bring all of them under the JFM network with the creation of 907 JFMC at the village level to foster better linkages with the Panchayati Raj Institutions. The district wise breakup of the village based JFMCs is as follows³⁰:

Table. 8.10: Number of Joint Forest Management Committee

S. No.	District	No of Villages (Panchayat wards)	No of JFMC/EDC
1	South District	255	255
2	East District	275	275
3	West District	274	274
4	North District	103	103
		Total	907

Source: Govt. of Sikkim, 2006.

³⁰ S.G.P.G- 159/ Gazetted 150 Nos./ Dt.- 27.05.2006, Govt. of Sikkim

Among the total 907 JFMC/EDC, East, West and South districts have the similar number of 275, 274 and 255 respectively. North district has least number of JFMC/EDC i.e 103. The figure is high and good in small state like Sikkim. However, the implementation and its effectiveness have observed (in the study area) dismal result.

Table. 8.11: Purpose of fuel use and their source (in percent)

Main purpose of firewood	Percent
Fuel not used	17.5
Mainly cooking fodder	24.8
Mainly heating	1.7
Fodder, cooking & heating	56
Total	100
Source of firewood	
Purchase	0.6
Collect from own property /land	12.3
Collect from reserved forest	4.3
Own land and reserved forest	65.8
Firewood not used	17
Total	100

Source: Field survey

The firewood is mainly use for the purpose of ‘fodder, cooking & heating’ which is respondent by 56% household. In high altitude and cold places like in north Sikkim, the firewood has multiple roles besides cooking fodder. It serves multiple purposes of cooking food/fodder as well as heating the room which is necessary to counter the cold climate. For instance, in ‘Lachen’, North Sikkim where every household depend on firewood not necessarily for cooking food irrespective of socio-economic backgrounds. The fodder cooking is the main component in rural areas because of the livestock rearing. It is observed that 24.8% of household exclusively use firewood for cooking fodder.

As far as source of firewood is concern, it is observed that majority of firewood is collected from the both ‘own land and reserved forest’ (65.8%) and 12.3% of household collects from their own land. It means that the majority of the household depends on own private land for firewood collection. It is because of the strict forest rules of Sikkim where it is not allowed to fell tree without the permission from the forest department even if it is in own private

property. Only the dried up branches are allowed to collect from the forest areas. On the other hand, the percentage of firewood per chance is minimal in Sikkim, only 0.6% are reported which also due to ban of rampant felling of tree.

Table. 8.12: Awareness about JFM and forest rules (in percent)

Awareness about JFM	Percent
Yes	4.3
No	95.7
Total	100
Awareness about forest rules and regulations	
Yes	28.2
No	71.8
Total	100

Source: Field survey

There are 907 JFMCs in Sikkim in each village panchayat wards where highest being in East district (275) and west district (274); lowest in North district (103). Despite such considerable number of JFMCs in rural areas, the awareness about the JFM is low. This argument is supported by the primary data which is presented in table 8.12. It is observed that only 4.3% households are aware about the JFM and 95.7% household responded that they do not have any clue about JFM. Likewise, ‘*awareness about forest rules and regulations*’ is also reported poorly as 71.8% household reported that they do not aware about any forest rule, only 28.2% responded that they are aware. This tells that there are some problems in the coordination or implementation from the supply side i.e government departments. It can be say that these JFMCs are inefficient or non functional in rural areas which needs to make more active. However, from the demand side, the role of education is important in the awareness programme. Though the joint forest management started in 2002, majority of the people are still unaware about JFM and their role/functioning. Therefore, it is necessary to make public aware about JFR and their role in community management of forest. It should be the duty of concern department of Sikkim i.e Ministry of Forests; Environment & Wildlife Management Department Government of Sikkim to make an effort to reach villages to aware about the “JFM” and how forest resource/environment can be manage which is a win-win situation for both parties. The role of JFM is critical in management of forest as rural people depend on it for various services like firewood, fodder and other forest products. As there

cannot be a complete ban on dependence on forest, therefore, it can be managed for its sustainable use with the active participation from local community and government officials.

Table 8.13: Dependence on forest (in percent)

		Percent
Household depend on forest other than firewood	Yes	81.8
	No	18.2
	Total	100
Consumption of fuel for non-food items	Livestock only	14.5
	Cold weather	1
	Livestock, lightening and heating	66.9
	Lightning and heating	17.6
	Total	100
Seasonal variation of firewood consumption	Yes	82.5
	No	2
	NA	15.5
	Total	100
Firewood consumption quantity	1 doko per week	2.3
	2 doko per week	9.5
	3 doko per week	24.2
	More than 3 doko per week	47.5
	NA	16.5
	Total	100
Firewood collection frequency	Weekly	6.2
	Monthly	1
	Winter/summer season	52.5
	Anytime, if needed	23.7
	NA	16.7
	Total	100
Firewood collection practices	Collect dead wood	6.8
	Cut branches of tree	0.5
	Deadwood, dead tree, cut branches	17.5
	All	58.5
	NA	16.7
	Total	100
Difficulties in getting firewood	Yes	63.8
	No	19.3
	NA	16.8
	Total	100
Difficulties in getting other forest products	Yes	65.5
	No	17.8
	NA	16.7
	Total	100
Observe any changes in forest cover/area over the years	Yes	99
	No	1
	Total	100
If yes, changes forest cover/area	Increasing	18.8
	Decreasing	78
	No change	3.2
	Total	100
Conventional use of firewood	Yes	69.2

(cultural/religion significance)	No	30.8
	Total	100
If yes,	daily prayer	5.2
	during cultural practices	3.8
	both	60
	no	31
	total	100
Food taste variation if cooked in firewood	Yes	74.8
	No	25.2
	Total	100

Source: Field survey

The fuel has various uses besides cooking food. For instance, fuel is used for other purposes like fodder cooking, heating and lightening purposes. In other words, fuels are used for other non-food consumption purposes as well besides cooking food. It is important to examine the non-food fuel consumption and other related issues to see the fuel consumption pattern. Therefore, the study tries to see these aspects as well. In this aspect, it is reported that 81.8% of household depend on forest other than firewood use like fodder. It is observed that 66.9% household responded that '*livestock, lightening and heating*' are the major purposes where firewood is consumed other than cooking food followed by '*lightning and heating*' (17.6%), '*livestock only*' (14.5%) and '*cold weather*' (1%). It is evident from the data that the complete fuel transition to clean fuel is not possible because of the factors like livelihood/livestock but the sustainable use of LPG for cooking in the house is possible by exclusively dividing cooking food and fodder with improvement in modern '*chullah*', kitchen with ventilation/window etc and provision of biogas plants in rural areas.

It is reported that by 82.5% responded that there is seasonal variation in firewood consumption where 52.5% reported that they collect/stock firewood in summer/winter (biannually) and 23.7% responded 'anytime, if needed' (daily). Such seasonal variation in fuel consumption can be balanced with the use of alternative fuels like bio gas plant, cow dung in fodder cooking. Such intervention will have various implications like; it will reduce dependency on firewood vis a vis forest/environment; and other hidden costs like time spent on firewood collection or cost incurred will reduce. The viability of such intervention is possible (even if not fully) because of the Sikkim's small geographical area (7096 sq km) and population size (6,55,604), the effective role of government departments is important. It is evident from the table that firewood consumption per day is very high in rural Sikkim, for

instance, 47.5% responded that they consume '*more than 3 doko*'³¹ and 24.2% responded '*3 doko per week*'.

However, firewood collection practices in Sikkim are sustainable in nature because of the ban of felling trees even in private land/forest. This is also highlighted in the data that majority of collection process include '*combination of deadwood, dead tree, cut branches*' and not a single house is reported that they fell standing/green tree for firewood use which is a positive sign. This point is substantiating with data on difficulties in getting firewood as 63.8% of the household responded that they find it difficult in getting firewood. Even in getting other forest products other than firewood observes difficulties as 65.5% responded they find '*difficult*' to get them and only 17.8% responded that do not find difficulties. It is because of the heavy dependence on these products.

Among other non-food consumption of firewood the factors like '*cultural/religion significance of firewood*' is also important aspect. Some household tend to dependent on firewood only because of the socio-cultural factors. It is considered that the fuel choice and adaptation of new energy technologies are also influenced by the individual characteristics, culture and tradition practices of region (Treiber, Grimsby and Aune 2015; Atanassov, 2010). Sikkim's population is mostly dominated by religious groups like 'Buddhist' and 'Animist'. Therefore, their culture requires nature worship; and prayer holds the central position in their rituals which frequently require fire/firewood for daily or at the time of rituals. Therefore, even if the household do not depend on firewood for cooking purposes, they tend to depend for cultural/rituals practices. Hence, it may be also attributed for the high firewood use in rural Sikkim. For instance, 69.2% household reported that firewood has cultural/ritual significance in their life and only 30.8% responded that they do not have any cultural/ritual significance. Further, it is reported that 60% household use firewood for daily as well as during cultural/ritual practices. Therefore, firewood use should not only look from the cooking purpose, the socio-cultural and ritual practices are also equally important in firewood use. In this aspect, government of Sikkim has taken sustainable policies regarding by allowing the collection of dry firewood from the forest area. Similarly, there is another reason to depend on firewood i.e. its variation of taste when food is cooked in firewood. It is

³¹ a local term for basket like feature made up of bamboo which usually uses to carry firewood in Sikkim.

observed that 74.8% household responded that taste of food varies if cooked in firewood and 25.2% responded ‘no’. This is another socio-cultural aspect of firewood use.

The critical aspect is changes of forest cover. The decreasing trend of forest covers as reported by respondents. It is reported that 99% observe any changes in forest cover/area over the years where 78.0% responded decreasing in forest cover/area while 18.8% is reported increasing and 3.2% observed no change. Despite the state government’s efforts the forest/area has been decreasing which needs an urgent solution. The decreasing trend shows the failure of the concern government departments to manage/conservate the forest cover/area. Among various reasons, growth of settlements, development schemes like construction of new roads in villages like “Pradhan Mantri Gram Sadak Yojana (PMGSY)”, footpath, tourist huts/rout construction in forest areas are prominent. It is also obvious that like earlier days forest is much less dense in present days. It also dependent on the perception of respondents on forests and it varies age wise. However, still 18.8% household responded that forest cover/area is increasing which is a positive outlook. With the existing strict rules and regulations on forest, there is a hope that the forest cover/area will increase in future.

Table 8.14: Factors hindering the firewood use in rural Sikkim

Physical and Environment	Economic and political	Socio-cultural
distance, monsoon, scarcity, time consuming, tiresome	Forest rule, deforestation, hidden cost	inefficient, smoke, new generation/lifestyle, manpower

Source: Field survey

The factors which hinders the firewood use among the rural people are categorized in to three broad category viz., ‘physical and environment’, ‘economic and political’ and ‘socio-cultural’. It is collected from the self reported response of the rural people. In ‘physical and environment’ category, the factors like distance, monsoon, scarcity, time consuming, tiresome have been the main factor that hider or discourage the use/depend of firewood. This implies that the availability of firewood is not easy even in the rural areas especially in monsoon time and the process of firewood collection is time consuming and requires physical strength. In ‘economic and political’ category, the strict rules/regulations are the main factors which check the use of firewood along with the consciousness of people about

the danger of deforestation. Further, the hidden cost associated with the collection of firewood is equally responsible for discouraging people to use/depend on firewood. In term of ‘socio-cultural’, the inefficiency of firewood and smoke that emits from the firewood burning is among the major factors along with the new generation/lifestyle, manpower. Now a days, younger generation do not want to use firewood as cooking fuel because of the new lifestyle driven by western culture which equates as low status. The young generation even in rural areas have rarely engage in firewood collection process rather they prefer other alternative source like LPG even if it costs high and consume time to get it from the market. The manpower to collect is hard to find in even in rural areas even if one is willing to pay money. In entire study area, there was no single person who sells firewood for livelihood. This is the situation even in the rural areas which is whether to consider good or bad but it is surely because of the changing lifestyle.

Table. 8.15: Firewood as compared to years ago

Firewood	Percent
Same	34.5
Better	1.3
Worse	64.2
Total	100

Source: Field survey

Overall, the level of firewood has been worse off as when it compared to five years ago. It is responded that the firewood availability has declined considerably where 64.2% responded ‘worse’ and only 1.3% responded ‘better’ and 34.5% responded ‘better’. Such level of firewood availability might be the reason behind the dependence on both firewood and mixed fuel simultaneously. In other words, the scarcity of firewood might be the reason behind the high percentage of ‘mixed’ fuel use in rural Sikkim for the fuel security reason.

In rural areas, the alternative to firewood like the distribution of improved cooking stoves, installment of biogas plants and expansion of LPG connection will help in reducing pressure on forests; and also indirectly helps in health condition (Nayak, Kohli, and Sharma, The Energy and Resources Institute, Livelihood of local communities and forest degradation in India: issues for REDD+).

8. Liquefied petroleum gas (LPG): Provision of LPG distribution system in Sikkim:

There is no fixed pricing system of LPG cylinder; and same is in Sikkim. In Sikkim, the Indian Oil is the sole LPG distribution agency and they fix the monthly price of cylinder (refill) in consultancy with state government. In cylinder refilling process, there is monthly variation in its price. In other words there is no fixed price to refill cylinder or there is monthly fluctuation in the cylinder refilling cost. It is reported by government official that sometime they fix the cylinder price considering price at the India level and also the distance to from their godown. For instance, longer the distance, higher the price consumers have to pay to refill a cylinder. The following table (old rates) shows the price variation of cylinder (14.2 kgs) in Sikkim.

Table.8.16. LPG rates across Sikkim

Sl. No	Distance from distributor's godown	Rate per cylinder
1	At distributors godown	Rs 426/-
2	Within 10 km radius	Rs 445/-
3	Between 10 km to 25 km radius	Rs 450/-
4	Between 25 km to 40 km radius	Rs 455/-
5	Beyond 40 km	Rs 465/-

Source: Government of Sikkim, 2013. Notification- Ref. No: 25/ FCS&CA.

The equal LPG rates across all the geographical regions should be there irrespective of geographical factors. The progressive rise in the price of LPG rates as per distance should be removed. Rationally, the rural people are the one who needs price concession not the people who lives in urban area. Contrary is the case in Sikkim, where urban people have to pay less to refill a cylinder where all the godowns are located; while rural people have to bear extra cost to refill a cylinder. The LPG Distribution Company and the state government should sign a memorandum of understanding (MoU) for the equitable LPG rates or normalizes the transportation cost.

Table.8.17: LPG use (in percent)

		Percent
Can afford LPG from income	Yes	75.7
	No	24.3
	Total	100
Source of LPG	Subsidized govt. programme	73
	Gas company	2.7
	Not used	24.3
	Total	100
Distance to travel to get LPG	1km/below 1 km	79.5
	Above 1 km	20.5
	Total	100
Fixed timing of LPG cylinder distribution	Yes	8.3
	No	91.7
	Total	100
LPG distribution system	Weekly	8.2
	Once in a month	36.3
	Do not have fixed time	25
	Do not have distribution system	30.5
	Total	100
LPG distribution frequency	Regular	24
	Irregular	76
	Total	100
LPG is easily obtained when in need	Yes	4.3
	No	95.7
	Total	100
Received LPG from govt.	Yes	29
	No	71
	Total	100

Source: Field survey

The LPG in Sikkim is mainly get through subsidized government rates from government distribution system. The entire households get the LPG from subsidized government programme or from Gas Company directly. There is no case of black marketing in the surveyed area, however the extra charge incurred to access in seems inevitable in rural Sikkim. For instance, in places where there is no/irregular LPG distribution system, one have to incur the price to the middle man like taxi driver as they take empty cylinder to the market

(urban area) and refill and get back to them. They (drivers) usually charge in the range Rs 100-200 per cylinder. These should be checked.

Income is one of the important aspects in accessing the LPG in rural Sikkim. The price of filled cylinder fluctuates frequently and on an average customer have to pay Rs 1000 or Rs 1100 for unsubsidized cylinder. In addition to this, customer in rural areas where there is no LPG distribution system or irregular distribution system; when they require filling the cylinder needs to pay extra money to middle man or drivers of taxi service for refill. People in rural areas usually have to face such problems in times when cylinder run out of gas. Further, there is no back up or reserved/filled cylinder in household in most of the cases. Therefore, there needs to be an intervention to deal all such problems. It is observed that 75.7% responded that they cannot afford LPG and 24.3% stated that they can. This 75.7% includes the household who have LPG connection (either self afforded or provided by the government) and those who do not have. Even having LPG connection people are reluctant to use it regularly due to factors like affordability, availability and accessibility.

To substantiate this argument, the geographical and supply mechanism has been analyzed. For instance, in terms of *'distance to travel to get LPG'*, it is observed that 79.5% responded state that they have to *'1km/below 1 km'* to get LPG. However, this is the distance to road where LPG distribution vehicle comes to distribute but it does not show the regularity of distribution system. On the other hand, 20.5% have to travel *'more than/above 1 km'* which does not have distribution system at all. Likewise, only 8.3% responded that they have *'fixed timing of LPG cylinder distribution'* while majority (91.7%) of them responded that they do not have fixed timing. In rural Sikkim, only 8.2% reported that they have weekly LPG distribution system while 36.3% states *'monthly distribution system'* and 20% and 30.5% reported have *'no fixed time'* and *'no distribution system'* respectively. This figure only tells about the LPG distribution system but not their frequency/timing. In terms of regularity of LPG distribution system, only 24.0% responded that they have *'regular distribution frequency'* while 76.0% responded that the frequency is *'irregular'*. Similarly, only 4.3% of household stated that LPG is easily obtained when in need while majority of them (95.7%) responded difficult to obtain when in need. The government's provision of free LPG connection system is also needs to maximize especially to BPL families, it is reported that

only 29.0% household received LPG from the government while 71.0% did not get or afforded from own expense.

Table 8.18: Factors hindering the LPG use in rural Sikkim

Physical and Environment	Economic and political	Socio-cultural
road condition/no road, monsoon time, distance	hidden cost/high cost, fluctuating price, income irregular/no distribution system, documents	cultural/tradition/religion, food habit/taste livestock, manpower

Source: Field survey.

In table 8.18, the major socio-economic-geographical factors have been categorized on the basis of self reported from the respondent in rural Sikkim. The factors like road condition, monsoon, time, distance are the main problems that the responded reported in accessing LPG. Among the economic and political category, factors like hidden cost/high cost, fluctuating price, income, irregular/no distribution system, documents were reported while cultural/tradition/religion, food habit/taste, livestock, manpower were reported as socio-cultural constraints. There needs to be urgent intervention from the supply/government side incorporating physical/environment, economic/political and socio-cultural aspects to maximize the LPG penetration and its regular use in rural Sikkim.

Table 8.19: Best solution for LPG distribution: Peoples’ prospective

Response	Percent
Fixed delivery timing	1.8
Fixed price	4.7
Fixed delivery timing and price	35.3
Documents	4.5
All	53.7
Total	100

Source: Field survey.

It is important to understand the response from the people about what would be the best solution for the LPG supply so that they can access the LPG. It is found that 35.3% responded ‘fixed delivery timing and price’ should be improve and ‘documents’ (4.5%) and

'fixed delivery timing' (1.8%) are other suggestions. Some rural people find difficulties in maintaining/keep documents ready (like Xerox of passbook and Aadhar card) at the untimely arrival of LPG distribution vehicle. However, 53.7% responded combination of all these aspects. It is therefore, recommend to improve the supply side of LPG distribution mechanism especially *'fixed delivery timing and price'*. The policy change in the requirement of Xerox copies of documents also needs to relook for easy accessibility of LPG in rural areas.

There is no black market in the Sikkim but hidden costs like money paid to those who receive and deliver at household level are beyond the actual cost. The hidden cost in the form of time spend on accessing cylinder are expensive in nature. People are unaware about the technical DTBS in rural areas. Majority people are unaware about how much money that their account credited and timing of credit. It is because of the unfamiliar with the use of technologies like mobile phones where instruction usually comes in English language which they cannot read. Therefore, people cannot have clear understanding of actual subsidies.

No cash in hand and banking services are complains that people have in rural areas at the time of arrival of LPG distribution vehicle. Other issues like documents, manpower to receive LPG cylinder needs to look upon. For instance, the Aadhar card is required to access LPG and some rural people still don't have it.

Table. 8.20: LPG as compared to years ago

LPG	Percent
Same	28
Better	71
Worse	1
Total	100

Source: Field survey

However, people think that the distribution system in rural areas have improved over the years. The factors like small area size, road accessibility, improved distribution system, political stability have contributed for improvement. The livelihood scheme like "MGNEGRA" and Shelf Help Groups (SGs) makes people capable of income generation; other social schemes like old age pension, widow pensions etc are praiseworthy. In terms of LPG availability, 71.0% responded that the availability of LPG has increased as compared to

five years ago. This is a positive sign which is due to the policies both from centre and state governments. The launch of new subsidized schemes on LPG like “PAHAL” or “Direct Benefit Transfer”, “Ujjwala” etc from the central government and the State government’s policies like ‘Janta Mela’³² where BPL people are given free LPG cylinder and gas stove are also right intervention. It is only 1% household responded that the LPG status is worse off than it was before five years whereas 28% responded ‘same’. Overall, the level of LPG in rural Sikkim is better off than it was before five years which is credit due to launch of new policies. Other factors like geography has important role in the availability of LPG, for instance, the size of Sikkim is small where the rural areas are easily served by the nearby urban centers. The process of urbanization has been rapid in Sikkim over the years which is also one of the important factors for the improvement in the LPG penetration in rural areas irrespective its regular use and refill.

However, despite having innovative State policies like distribution of LPG through ‘Janta Mela’, free constructions of biogas plant, free electricity (upto 100 units) to BPL families there are few concerns regarding the equal distribution of these schemes to people. The discrimination in the selecting beneficiary is one major concern as the process is greatly influence by the political party affiliation. The role of selecting the beneficiaries is the sole responsibility of grass root governance in rural Sikkim like Panchayat. The Panchayat is like a political agent in rural areas and has the role in monopoly in selecting beneficiaries which sometimes ignore the genuinely entitled people from the schemes. Therefore, such political victim practices should be checked to provide social schemes to all the eligible people irrespective of their political affiliation, caste and social background.

The grievance-redresses system should be there at the Gram Sabha level if not at village level where customer grievances should be address regularly. The awareness generation programme among rural people should be organized at least once at village level where people should be enlightened in LPG enrolment, subsidy and benefit of using LPG. The banking services need to strengthen. In addition, it is observed that due to lack of manpower to deliver the filled cylinder rural people sometimes hesitate to use/depend on LPG.

³²a public scheme distribution event in Sikkim where LPG, inductions are distributed among others to BPL families.

Therefore, the provision of manpower (from village itself) to provide cylinder services to household should be there at every village level.

9. Kerosene and electricity:

Sikkim is allotted 546 KL of Kerosene Oil per month. This is issued through Fair Price Shops/Ration Cards at a scale of 1.25 liters per individual in rural areas and 1 liter in the urban areas. (Government of Sikkim 2010-2011). However, the use of kerosene as cooking fuel is minimal in Sikkim; it is used only for heating purpose or purposes like lightning at night and to start burning of fire. The kerosene is distributed from the “Public Distribution System (PDS)” through ration card where an individual member of a household is entitled to get at subsidized rate Rs 25 per liter. Besides PDS, kerosene can also be purchased in unsubsidized price which cost Rs 50 per liter. However, the critical issue is that even availing kerosene at minimal price its usage as cooking fuel is low. Therefore, the possibility of kerosene use as cooking fuel seems outdated which needs a critical policy evaluation.

Table. 8.21: Factors hindering the Kerosene use in rural Sikkim

Physical & environment	Economic & political	Socio-cultural
inefficient	insufficient	livestock
smoke	irregular distribution system	time consuming

Source: Field survey

In physical/environmental category, the factors like smoke and inefficient are the major problems in accessing kerosene. In economic/political sphere, factors like insufficient, irregular distribution system are major factors. Likewise, livestock, time consuming are the socio-cultural constraints that are discouraging the dependence on kerosene. It is not possible to cook fodder in kerosene based stove.

Table.8.22: Kerosene as compared to years ago

Kerosene	Percent
Same	28
Better	7.5
Worse	64.5
Total	100

Source: Field survey

The availability of kerosene has been worse off as 64.5% household responded that the kerosene is ‘worse’ compared to five years ago. It is only 7.5% responded ‘better’ while 28%

responded that the kerosene availability is ‘same’. The low use of kerosene as cooking fuel is not actually because of its availability but it is because of its utility/relevance as fuel in present day. Even if there is availability of kerosene, people hardly use it as fuel. The true picture is that the utility of kerosene as cooking fuel has no relevance in the present day. Therefore, respondent has responded it as its poor availability but the real picture is its relevance as fuel in today’s world. Like kerosene, the use of electricity as cooking fuel is also limited. The provision of electricity supply is poor especially in rural Sikkim. It is reported that electricity supply is irregular in most of the time. However, there is 100% household is electrified in the study area which is above all India figure of 95% (NITI Aayog 2018; Duflo et al 2008; Heltberg 2004, 2005; World Bank 2003).

Table. 8.23: Electricity use (in percent)

		Percent
Frequency of power (electricity) supply	Regular	8.8
	Irregular	91.2
	Total	100
Seasonal electricity disturbances	Yes	91.8
	No	8.2
	Total	100
Subsidized electricity	Yes	36.5
	No	63.5
	Total	100
Received induction from govt.	Yes	1.5
	No	98.5
	Total	100
Electricity in heating	Yes	51.8
	No	48.2
	Total	100
How often electricity is used for heating	Regular	46.5
	Sometimes	5.5
	Never	48
	Total	100
Electricity in cooking	Yes	5.8
	No	94.2
	Total	100
How often electricity is used for cooking	Regular	0.2
	Sometimes	6
	Never	93.8
	Total	100

Source: Field survey

In terms of frequency of power (electricity) supply, it is reported that only 8.8% respondent said that they have regular electricity supply while majority (91.2%) responded irregular. Likewise, seasonal electricity disturbances also show similar response where 91.8% responded that they face seasonal disturbance. The percentage of household who have subsidized electricity connection is also low. There is a provision in state government’s policy in providing free electricity to BPL if the household consume not more than 100 units. But, if the household consume more than that then they have to pay the full bill for the total number of units household consume. Similarly, there is provision of providing free electric based induction for BPL families but the percentage of household beneficiaries in the study area is low. The policy and the gap in its implementation in ground need to evaluate and bring down systematically. It is only 1.5% of households have received induction from state government. The use of electricity in heating purpose is high than the cooking purpose. It is reported that 51.8% household uses electricity in heating purposes especially in heating water which 46.5% responded its regular use and 48.0% of household reported ‘never’. Contrarily, only 5.8% household use electricity in cooking purpose while 94.2% household do not use electricity in cooking food. This is further substantiate by the 93.8% household never use electricity for cooking food.

It normally takes 2-3 or more days to restore the electricity supply after sudden cut off which is mainly due to climatic and geographical factors. The response from the government department to restore the electricity cut is slow. Although there is provision of a lineman who looks for the electricity supply in villages, the work efficiency is poor which needs to be strengthened. In this context, the government of India’s scheme i.e. “Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)” has failed to provide its aim i.e. to provide 24x7 supply of power in Sikkim.

Table.8.24: Electricity as compared to years ago (in percent)

Electricity	Percent
Same	2
Better	98
Worse	0
Total	100

Source: Field survey

A comparative analysis over the five years has shown that the condition of electricity has improved significantly. As 98% respondent state that the condition is 'better' that it was before five years ago. Surprisingly, no one responded that the condition is worse off while 2% responded 'same' as it was before. Therefore, the provision of electricity in rural Sikkim has improved considerably. However, the frequency or the regular/undisturbed supply of electricity is a big concern which is due to various factors embedded in geographical structure, deployment of manpower (lineman and their efficiency) in rural areas and efficient Energy and Power department, the Government of Sikkim.

There is a possibility of electricity use as cooking as well as heating water purposes given the hydro-electricity rich state. Sikkim has dense hydro-electricity power plants of various Units (small, medium and large) with huge natural potential because of availability of high velocity of streams/rivers. The electricity production is surplus in state which exports to the mainstream electricity grid. In addition, the population size and area is also small which is 610577 and 7096 sq km respectively. Therefore, the possibility of provision of free electricity to all the rural population (if not urban population) is viable option to make people access to clean cooking fuel. However, to make it possible, the geographical factors need to take into consideration with cutting edge infrastructure for uninterrupted electricity supply in rural areas. It is possible if the state government sign "Memorandum of Understanding (MoU)" with power plant developers and central government considering the factors like location of Sikkim in climate sensitive Easter Himalaya, border state and the kind of history that Sikkim have (Sikkim was merged in 1975 with India by abolishing Kingdom system and protected by 371 F- a special provision).

The other alternative source is biogas plant. The Government of Sikkim has provision of providing/construction of biogas plant to rural household. However, the success rate of biogas plant use is low due to factors like geographical, continuous input supply and maintenance cost, lack of awareness.

10. Environmental Awareness:

It is very important to have basic awareness of surrounding areas/environment. In recent years, the issues like climate change, environmental degradation, global warming has been burning issues at global, regional and local level. The first step to contribute to deals such

crisis would be to have basic public awareness about the environment and their conservation/management. In this aspect, a self reported assessment has been done in rural Sikkim.

Table.8.25: The level of environment awareness in Sikkim (in percent)

Awareness about forest rules and regulations	Yes	28.2
	No	71.8
	Total	100
Awareness about JFM	Yes	4.3
	No	95.7
	Total	100
Awareness about indoor air pollution	Yes	42.8
	No	57.2
	Total	100
Management of forest by government	Effective	64.8
	Ineffective	35.2
	Total	100
Forest conservation and protection is also your responsibility	Yes	64.7
	No	35.3
	Total	100
Previous participation in forest management	Afforestation	28.8
	Clearing forest bushes	39.8
	No participation	31.3
	Total	100
Frequency of afforestation programme	Half-yearly	0.7
	Yearly	81
	No afforestation programme	18.3
	Total	100
Frequency of forest officials visit in forest area	Regular	33.5
	irregular	66.5
	Total	100

Source: Field survey

The use firewood has negative impact consequences like indoor air pollution, deforestation, labor intensive firewood collection process (Smeets, Francis, Johnson and Ballard-Tremeer 2012). The awareness about the forest rules and regulation and the “Joint Forest Management (JFM)” is poor in rural Sikkim. Only 28.2% responded that they are aware about the forest rules and regulations while 71.8% responded ‘no’. Likewise, 95.7% respondent does not know about the JFM, only 4.3% are aware about the JFM. Further, the percentage of household who are aware about the indoor air pollution caused by burning of firewood and their health implications is also low. It is observed that 42.8% responded that they are aware

while 57.2% do not have any idea about it. Indoor air pollution is embedded in various socio-economic factors has various health implications especially on women and children (Brown, Dassonville, Derbez, Ramalho 2015).

In Sikkim, the forest is looked and managed by Forests, Environment & Wildlife Management Department, the Government of Sikkim. It is observed that 64.8% responded that it is 'effective' in its conservation/management process while 35.2% responded 'ineffective'. The percentage to those who thinks that *'forest conservation and protection is also your responsibility'* is also 64.7% while 35.3% thinks 'no'. Their way of participation in the forest management/protection come in the form of afforestation (28.8%), clearing forest bushes (39.8%) while 31.3% do not participate. The frequency of afforestation programme is mostly done annually (81.0%) and 18.3% responded state that there is no afforestation programme in village. In terms of *'frequency of forest officials visit in forest area' in rural Sikkim'* 66.5% responded that the official's visit is irregular while 33.5% responded 'regular'.

The need to create public awareness about environment is felt in rural Sikkim. The schools would be the focal point of environment education. The need to public awareness camp can be other alternative especially for aged old population and those who did not get formal education. The public awareness camp can be organized by government as well as (NGOs) about the environment in general and harmful effect of firewood use as cooking in particular. This can be done with the presentation of visual (video) aid in the form of short films or documentary. The frequency of programme can be organize bi-annually or annually along with some practical programmes like afforestation. The aim of the programme should be to make public conscious about the environment and importance of their active participation in the conservation/management process in long term.

Sikkim has been always set a standard in terms of taking environment initiatives. For instance, total ban of plastic/firecracker, first organic state of India etc. Therefore, to invest in rural areas to create public awareness should not be a big deal. The Government of Sikkim can organize such programmes by integrating with other programmes like health, agriculture, livestock, horticulture, social schemes etc.

10. Summing up:

The Indian energy policy is mainly dominated in sectors like solar, petroleum, uranium, electricity, LPG etc. There are various policies in these regards in various levels with systematic implementation mechanism. However, there is no so plan mentioned for alternative cooking fuels like firewood, kerosene and electricity. This aspect needs to bring into policy framework. The implementation mechanism has failed to meet the guidelines laid in the policy framework in ground level. In case of LPG, there is a “DBT” scheme or “SAUBHAGYA” scheme which aims to provide the free LPG connection to the BPL family especially women in rural areas. Although the impact of the scheme has been felt but it is not up to the expectation that the Government of India has laid down in its policy framework.

In rural Sikkim, there are still many problems where the supply of LPG from the government side is not only the problems. The various problems like infrastructural intervention should make considering the demand the side mechanism. The infrastructural intervention in the form of all weathered road connection in rural areas, fixed distribution and fixed price mechanism, public awareness, hassle free documents like Xerox Aadhar/LPG passbook need to look after. In addition, despite the provision of free LPG distribution to rural people the other aspects like the capability to afford or refill the LPG cylinder after its use also needs to evaluate so that rural people do not find problem in refill process. Here, the capability to afford the LPG needs to need to understand. Even after distribution of subsidized cylinder, people are still unable to afford due to low income and high cylinder price which is around Rs 1100 (without subsidized rate). Here, people have to pay Rs 1100 (approx value, varies monthly) at first, then only the subsidized amount is credited to their bank account which takes time. This process has puzzled lots of people because at first people find hard to manage that first amount of installment, secondly due to lack of awareness people are unable to understand the procedure of subsidy which credited in their bank account. Although the cost of subsidized cylinder seems cheap and affordable but in actual, it's real cost is high especially in rural people.

In firewood use, there is no concrete policy in the Government of India's plan. However, the act of Government of Sikkim in its policy is praiseworthy as there is complete ban of tree felling; only deadwood or dead branches are allowed to collect/fell. People are allowed to fell

tree only in case of emergency like if it pose risk to house that also requires permission from the Forest Department, GOS even the tree is from private land. Such policy needs to formulate with legal binding by the Government of India as well in more concrete/strict way so that all the states adopt it properly.

The provision of electricity to all the rural areas in free of cost is feasible. The Government of Sikkim needs to work to provide free electricity to all the BPL families in rural areas irrespective of economic cost. The electricity connection in Sikkim has good record but the only concern is its frequency. Therefore, the Government of Sikkim needs to strengthen this aspect to provide uninterrupted electricity supply to all especially in rural areas; so that there is rise in electricity use in cooking practices- a clean fuel.

CHAPTER 9

SUMMARY AND CONCLUSION

Globally, the environmental issues like climate change, global warming and environmental degradation have been hunting. The little progress has been done or implemented in real sense to address such issues. The global communities are still in dilemma and bargaining about their responsibility to deal without realizing that these environmental issues are borderless in nature and pose great threat to planet earth. These issues need to address urgently for sustainable living for all.

The Sustainable Development Goals which was launched in 2015 aim to make earth sustainable for all. It is a comprehensive set of goals/targets which incorporates every aspect to make our planet earth better for all. Amongst various goals, the goal number 7 deals with the “affordable and clean energy” for all. The thesis is based on this goal especially related to household cooking fuel use which tries to understand and analysis it in the very local context i.e the study area, rural Sikkim. Sikkim is a tiny Easter Himalayan state located in the North east India. Sikkim is bordered by China in the east and north, Bhutan in the east, Nepal in the west, in south it shares border with Indian state of West Bengal. The justification in selecting the Sikkim as study area is: firstly, Sikkim is an Eastern Himalayan state which is rich in biodiversity and provides various environmental services but also sensitive to climate change and environmental degradation. Any disturbances in its natural milieu will result a great ecological-environmental destruction. Secondly, there is high percentage of people dependent on firewood as cooking fuel and the gap is wide between urban and rural areas where considerably high percentage of people has been using firewood as fuel. The dependence on firewood has negative socio-economic and environmental implications. Therefore, considering all these aspects, the location of study area has been identified for further research with the objectives and research questions pertaining to socio-economic characteristics and determinants of various household cooking fuel use and intervening factors associated with complete “fuel switching” to clean fuel in rural Sikkim.

Household cooking fuel is broadly categorized into clean or modern fuel and solid fuels.

Clean fuel: Clean fuels are those which do not leave much residue and smoke which do not pose much environmental or public health concerns. For example, LPG and CNG are classified as clean fuels.

Solid fuels: Charcoal, firewood and kerosene is referred to as solid fuels or unsafe fuel. These are rudimentary and unsafe forms of cooking fuel which have environmental and public health concerns. Emission from such fuels releases black carbon which is a main component of global warming and climate change.

In Sikkim only three types of cooking fuel are prominent viz. firewood, LPG and mixed (both firewood and LPG) where dependence on other fuels is very low. Total 14 villages were selected as study areas where 5 villages were from West district and 3 villages each from East, North and South districts. Sikkim has only 4 districts. It is found that majority (58.7%) of households are dependent on mixed fuel i.e. both firewood and LPG where 24.5% are dependent on 'firewood only' and only 16.8% are dependent on 'LPG only'. This data indicates that the "multiple ladder" model is relevant in fuel use in Sikkim. Unlike "ladder model", the "multiple ladder" explains that there are other socio-economic factors as well which determine household cooking use. The "ladder energy" model which states that income is only a factor that determines clean fuel use.

Based on field survey, South district has a high percentage of firewood use (36.7%), followed by East district (32%), West district (18.5%) and North district (15.3%) respectively and the aggregate state average is 24.5%. In terms of 'LPG only' use, East district has a high percentage (29%) above the state average (16.8%) outperforming the other districts. East district is followed by South district (18.7%), West district (13.5%) and North district (11.3%) respectively. In terms of mixed fuel use (both firewood plus LPG), North district performs well with an average of 73.3% followed by West district (68%), South district (44.7%) and East district (39%) respectively. The easy availability of firewood might be the reason behind the dependence on both firewood and mixed fuel use along with fuel security reasons. Among religious groups, 'Buddhist' and 'animist' households are more dependent on firewood than other religious groups like Christianity and Hindu; the socio-cultural practices are the

reasons. In terms of social groups, ST households have low percentage of LPG use (10.9%) than other groups below state average (16.18%). The percentage '*mixed fuel*' use has been high. This is due to the nature of work and cultural/traditional practices that the household engaged and their way of life. The dependence on firewood is directly related to the nature of work (livelihood) that household is engaged. In other words, people tend to depend more than one cooking fuels mainly because of the nature of their work, agricultural practices, animal domestication, availability of alternative cooking fuels, irregular/infrequent distribution of LPG system, fuel security, food and taste factors, cultural and traditional factors. The dependence on firewood is inevitable in the cooking fodder for livestock which in a part of their livelihood. The use of other fuels like LPG is simply not viable for the fodder cooking, even in case if viable, its cost is too high to afford. It is observed that most of the people segregate their fuel as cooking food and cooking fodder. In fodder cooking, they exclusively use firewood and LPG in cooking food they use both i.e firewood and LPG (if available). The people are still dependent on traditional '*chullah*' system in rural Sikkim; but most of them have separate kitchen room along with the ventilation or window/chimney facilities.

Along with other socio-economic factors, the urbanization is an important for fuel choice (World Bank 2003; Horst and Hovorka 2008; Pachauri and Jiang 2008; Arnold, Kohlin and Persson 2006). In other words, the urbanization is one of the major factors in determining the clean fuel use. Generally, the urbanization process is seen as the alternative way of providing clean energy. The rate of urbanization also influence the household energy consumption pattern, as the urbanization increases, there is lesser chances of firewood use demand (Arnold, Kohlin and Persson 2006; Pachauri and Jiang 2008). In Sikkim, it is observed that the most urbanized district i.e. East District has the highest percentage use of LPG both in rural and urban areas. In addition, the local governance system also important factor in accessing the LPG in Sikkim irrespective of topographical constrains. For example, the practice of Dzumsa (a local governance system) in Lachen (located at far North district with many topographical constraints) is powerful and effective; therefore the delivery of social schemes likes LPG is not so big deal even its location challenging-physically/topographically.

The gender aspect cannot be ignored when it comes to fuel use. In the study area, majority of the household head is men and they take major household decisions which reveal some gender issues in managing the household activities. In other words, most of the household activities and decisions are in the hand of men where the percentage of women's participation found comparatively low. But, it cannot be said precisely that it is because of the practice of patriarchy; the factors like the division of labor in managing household activities are among the other reasons. The household role of men and women cannot be simply attributed to the patriarchy. It is more attributed to the division of labor, lifestyle practices, livelihood and livestock etc. For instance, division of labor in outdoor and indoor activities; men tend to engage more in outdoor activities which is physically demanding while women in indoor which is less physical. Therefore, it would be wrong to single out the existence of gender discrimination simply because of the division of labor. In health aspect, this research could not find any conclusive evidence of firewood use and its impact on health of women and children. This is one of the limitations of this study. In this aspect, it is suggestive to do comprehensive research in collaboration with various stakeholders from various research backgrounds.

To make LPG accessible to all the areas, it is essential to have efficient distribution system. It is also suggested by Treiber, Grimsby and Aune (2015). In rural Sikkim, the LPG distribution is not regular or do not have fixed time of service delivery. Majority of respondent states that due to irregular distribution system they need to depend on firewood even if they have LPG connection simply because of fuel security reason. The need to strengthen the LPG distribution is highly felt to make LPG accessible to all. The social-economic and geographical factors like '*BPL household*', '*awareness about the government schemes*', '*income*', '*affordable of LPG*', '*LPG received from government*', '*distance to travel to get LPG*' and '*LPG distribution system*' are important factors in accessing the clean cooking fuel or transition from '*firewood*' to '*LPG*' in Sikkim. It is imperative to improve these factors to make LPG available and accessible to all rural people. In general, '*income*' and '*supply side*' variables are important factors in accessing the LPG in rural Sikkim. Therefore, the role of government policy seems to play a major role in providing free LPG connection to rural people. The role of government in providing services like free and affordable LPG and its regular distribution system is highly felt to access clean fuel for all. It

is suggestive to strengthen the government policy to review the LPG distribution policy and create mass awareness among people about the LPG use and its benefit. There should be maximum subsidiary support from government especially in refilling LPG cylinder process in rural areas. If the government can provide free LPG connection to poor or BPL families then they should also provide high subsidy to these people in refilling cylinder. The high subsidy in refilling would result the high percentage of actual or regular use LPG which is the ultimate aim of the scheme. The free LPG distribution should be more rampant and should reach to those who are genuinely entitled. The task of identifying the beneficiaries is one major task to deal due to political interference. This needs to be work out and all the BPL families need to provide free LPG connection irrespective of political affiliation of individuals. It is suggestive to make 'junta mela' (a public distribution system where social schemes like LPG/electric based induction cook stove are distribute; although this is an innovative idea but it is irregular and political in nature) more inclusive and regular in nature. In addition, the distribution of induction cook stove needs to be rampant; but strengthening the regular subsidized electricity supply is needed.

In rural Sikkim, there are still many problems where the supply of LPG is not the only problem. The infrastructural intervention in the form of providing all weathered road connection in rural areas, fixed price and distribution mechanism, public awareness, hassle free documents like Xerox Aadhar/LPG passbook need to look after. In addition, despite free LPG distribution to rural people the other aspect like the 'capability' to afford or refilling of LPG cylinder needs to evaluate so that rural people will find no problem in accessing. The 'capability' to afford the LPG needs to need to understand because even after subsidized cylinder people are unable to afford due to low income and high price cylinder refilling. Although the cost of subsidized cylinder seems cheap and affordable but in actual, it's real cost is high especially in rural people. On a positive note, the practice of black market in LPG is absent in Sikkim; however, the opportunity/hidden cost is high which needs an urgent policy intervention. For instance, manpower to get refill (driver), manpower to deliver filled cylinder at house (labor), time spend in waiting for refill etc. The equal LPG rates across all the geographical regions should be there irrespective of geographical factors. The progressive rise in the price of LPG rates as per distance should be removed. The LPG Distribution

Company and the state government should sign a memorandum of understanding (MoU) for the equitable LPG rates or normalizes the transportation cost.

In many studies it is mentioned that household income is single most strong determinants of fuel choice (Gupta and Kohlin 2006; Pachauri and Jiang 2008.); Leach (1992); Farsi et al 2007; Link, Axinn and Ghimire 2012). However, in this studies income is not the only factor that is determining the fuel choice. There are other socio-economic and environmental factors as well which have influential role in fuel choice. Similar study opined that the role of individual characteristics, culture and tradition practices of region which have influence the fuel choice/use. (Treiber, Grimsby and Aune 2015; Atanassov 2010).

The factors like distance, monsoon, scarcity, time consuming, tiresome, forest rule, inefficient, smoke, new generation/lifestyle, manpower, deforestation and hidden cost are intervening factors in firewood access. In case of kerosene, factors like inefficient, smoke, insufficient, irregular distribution system, time consuming and livestock are major factors that intervenes kerosene use. Likewise, the factors like road condition/no road, monsoon, time, distance, hidden cost/high cost, fluctuating price, income, irregular/no distribution system, documents, cultural/tradition/religion, food habit/taste, livestock and manpower are major intervening factors in accessing LPG. In addition, the factors like affordability, availability, easy to use, efficiency and pollution are major determinants in fuel choice along with the behavior attributes like '*conventional use of firewood (religion/cultural significance)*' and '*food taste variation*' in rural Sikkim. Fuel security is one the reason for people's dependence on firewood because the other alternative fuels like LPG is inconsistent in rural Sikkim. Therefore, the need to understand the behavior attributes of people are important for the successful implementation of government schemes. In fact, the implementation mechanism of free/subsidized LPG connection Government of India has dismal report in ground level especially in rural areas. The impact of the scheme is not up to the expectation that the Government of India laid down in its policy framework. For instance, "PAHAL (Pratyaksha Hastaantarit Laabh)" in November was launched in 2014 with the primary objectives of improvement in the of LPG delivery system, subsidized cylinder to the entitled consumers and check on the unauthorized diversion or duplicate connections. These objectives are hardly meet in rural Sikkim; only positive is found from

the field is that there is no diversion or duplication. However, the newly launched of the Pradhan Mantri Ujjwala Yojana (PMUY) scheme is recent in nature (2016), which aims to provide free LPG connection to the BPL families especially women in rural areas. Therefore, its impact can take time to analysis; and this study cannot tell the efficiency of this scheme in short period of research time; which is one of the limitations of this study.

The firewood is essential part of the rural people because of their socio-cultural practices. The climatic and geographical factors are also determines firewood use. For instance, in Lachen (North district) the prevalence of cold climatic condition also compels people to depend on firewood to counter the low temperature. In forest conservation, the policy of the Government of Sikkim is praiseworthy as there is complete ban of tree felling; only deadwood or dead branches are allowed to collect/fell. People are allowed to fell tree only in case of emergency like if it pose risk to house; that also requires permission from Forests, Environment & Wildlife Management Department, the Government of Sikkim even the tree from private land. Such policy needs to formulate with legal binding by the Government of India as well so that all the states adopt it properly. However, the critical aspect is changes of forest cover. Despite such strict rules and regulations people responded that 78.0% responded decreasing in forest cover/area over the years while 18.8% is reported increasing and 3.2% observed no change. Despite the state government's efforts the forest/area has been decreasing which needs an urgent solution. The decreasing trend shows the failure of the concern government departments to manage/conservate the forest cover/area at ground level. The active role Joint Forest Management (JFM) is highly felt to manage forest area/land in a sustainable manner.

However, the use of kerosene as a cooking fuel has lost its significance. It is suggestive to evaluate the policies on kerosene. The scheme on kerosene can be divert to strengthen other existing schemes like LPG, biogas, electricity. The possibility of biogas plant is also possible due to availability of inputs. Now the Sikkim has become a fully 'organic state' which further enhances the viability of biogas plant. Now, the existing policy plans on the provision of biogas plants needs to restructure for its efficient implementation.

In case of electricity, there should be provision of free electricity to all the rural areas which is feasible. The Government of Sikkim needs to work to provide free electricity to all the

BPL families in rural areas irrespective of economic cost. Although the electricity connection is observed 100% in the study area, the use of electricity in cooking is minimal and its frequency is the major concern. Further, it is observed that the use of other electronic devices like rice cooker, water boiler, water heater, mixture etc is common. So, there is possibility to maximize the percentage of electricity based induction use in Sikkim. The high percentage of electricity connection needs to convert in high percentage use of electricity based cooking practices which is very much possible considering small geographical area, small population size and high number of hydro electricity plants. In addition, Sikkim is a border state with a great environmental significance which is also governed by a special provision of the Constitution of India i.e. 371 F. Therefore, it is suggestive to the GoS to sign the MoU with Central government and hydro plant stakeholders to provide free and uninterrupted supply of electricity to rural people for the sustainable future.

Reference

- Agarwal, A., & Agrawal, V.K. (2011). Impact of tobacco smoke on tuberculosis: A case control study. *National Journal of Integrated Research in Medicine*, 2(3), 38-42. Retrieved from <http://njirm.pbworks.com>
- Alam, M., Sathaye, J., & Barnes, D. (1998). Urban household energy use in India: Efficiency and policy implications. *Energy Policy*, 26(11), 885-891. doi:10.1016/S0301-4215(98)0008-1
- Albalak, R., Frisancho, A.R., & Keeler, G.J. (1999). Domestic biomass fuel combustion and chronic bronchitis in two rural Bolivian villages. *Thorax*, 54, 1004-1008. Retrieved from <http://www.thorax.bmj.com>
- Angelou, Nicolina and Mikul Bhatia (2014): "Capturing the Multi-dimensionality of Energy Access," Live Wire Knowledge Note Series; No 2014/16, Washington DC: World Bank Group.
- Arnold J.E.M, Kohlin G and Persson R (2006). 'Wood fuels, Livelihoods, and Policy Interventions: Changing Perspectives', *World Development* Vol. 34, No. 3, pp. 596-611.
- Balachandra, P. (2011a). Modern energy access to all in rural India: An integrated implication strategy. *Energy Policy*, 39, 7803-7814. doi:10.1016/j.enpol.2011.09.026
- Balachandra, P. (2011b). Dynamics of rural energy access in India: An assessment. *Energy*, 36, 5556-5567. doi:10.1016/j.energy.2011.07.017
- Baland J.M, Bardhan P, Das S, Mookherjee D, Sarkar R, (2010). 'The Environmental Impact of Poverty: Evidence from Firewood Collection in Rural Nepal', The University of Chicago.
- Behera, D., Dash, S., & Yadav, S.P. (1991). Carboxyhaemoglobin in women exposed to different cooking fuels, *Thorax*, 46, 344-346. Retrieved from <http://www.thorax.bmj.com>
- Benemann, J.R. (1980). Biomass energy economics. *The Energy Journal*, 1(1), 107-13. Retrieved from <http://www.jstor.org/stable/41321458>
- Bhasin Veena, 1989 '*Ecology, Culture and Change: Tribals of Sikkim Himalayas*', Inter-India Publications, New Delhi.
- Boy, E., Bruce, N., & Delgado, H. (2002). Birth weight and exposure to kitchen wood smoke during pregnancy in rural Guatemala. *Environmental Health Perspectives*, 110(1), 109-114.
- Brown Terry, Dassonville Claire, Derbez Mickael, Ramalho Olivier (2015). 'Relationships between socioeconomic and lifestyle factors and indoor air quality in French dwellings', *Environmental Research* (385-396).
- Bruce Y, Vijayaraghavan M, and Bhattarai M (2002). 'The Environmental Kuznets Curve A Primer', PERC Research Study.
- Bruce, N., Perez-Padilla, R., & Albalak, R. (2000). Indoor air pollution in developing countries: A major environmental public health challenge. *Bulletin of the World Health Organization*, 78(9), 1078-1092.
- Bruce, N., Rehfuess, E.A., Smith, K.R. (2011). Household energy solution in developing countries. In Nriagu J.O. (Ed.), *Encyclopedia of environmental health*, vol. 3 (pp.62-75). Burlington: Elsevier.

- Bryce, J., Pinto, C.B., Shibuya, K., & Black R.E. (2005). WHO estimates of the causes of death in children. *The Lancet*, 365, 1147-1152. Retrieved from <http://www.thelancet.com>
- Chettri N, Sharma E, Deb D. C. and Sundriyal R. C., (2002). ‘Impact of Firewood Extraction on Tree Structure, Regeneration and Woody Biomass Productivity in a Trekking Corridor of the Sikkim Himalaya’, Source: Mountain Research and Development, Vol. 22, No. 2 pp. 150-158, International Mountain Society.
- Cook, D.G., & Strachan, D.P. (1997). Parental smoking and prevalence of respiratory symptoms and asthma in school age children. *Thorax*, 52, 1081-1094. Retrieved from <http://www.thorax.bmj.com>
- Cox, S, J Katz and Laura Württenberger (2014): ‘Assessing Development Impacts Associated with Low Emission Development Strategies: Lessons Learned from Pilot Efforts in Kenya and Montenegro’, Technical Report, National Renewable Energy Laboratory.
- Crampin, A.C., Glynn, J.R., Floyd, S., Malema, S.S., Mwinuka, V.K., Ngwira, B.M.M., Fine, P.E.M. (2004). Tuberculosis and gender: Exploring the patterns in a case control study in Malawi. *The International Journal of Tuberculosis and Lung Disease*, 8(2), 194-203.
- D’Sa, A., & Murthy, K.V.N. (2004). LPG as a cooking fuel option for India. *Energy for Sustainable Development*, 8(3), 91-106.
- Desai, M.A., Mehta, S., & Smith, K.R. (2004). Indoor smoke from solid fuels: Assessing the environmental burden of disease at national and local levels. Geneva: WHO (WHO Environmental burden of disease series, No.4).
- Desai, S.B., Dubey, A., Joshi, B.L., Sen, M., Shariff, A., & Vanneman, R. (2010). Human development in India: Challenges for a society in transition. New Delhi: Oxford University Press.
- Dominguez-Almendros, S., Benitez-Parejo, N., & Gonzalez-Ramirez, A.R. (2011). Logistic regression model. *Allergol Immunopathol.* doi:10.1016/j.aller.2011.05.002
- Duflo, E., Greenstone, M., & Hanna, R. (2008). Cooking stoves, indoor air pollution and respiratory health in rural Orissa. *Economic and Political Weekly*, 43(32), 71-76. Retrieved from <http://www.jstor.org/stable/40277832>
- Edwards John H. Y. and Langpap Christian, (2005). ‘Startup Costs and the Decision to Switch from Firewood to Gas Fuel’, *Land Economics* Vol. 81, No. 4, pp 570-586, University of Wisconsin Press.
- Ekholm, T., Krey, V., Pachauri, S., & Riahi, K. (2010). Determinants of household energy consumption in India. *Energy Policy*, 38, 5696-5707. doi:10.1016/j.enpol.2010.05.017
- Ezeh K.O, Agho K.E, Dibley M.J and Hall J.J, (2014). ‘The effect of solid fuel use on childhood mortality in Nigeria: evidence from the 2013 cross-sectional household survey’, *Ezeh et al. Environmental Health* 2014, 13:113.
- Ezzati, M., & Kammen, D.M. (2001). Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: An exposure-response study. *The Lancet*, 358, 619-624. Retrieved from <http://www.thelancet.com>
- Ezzati, M., & Kammen, D.M. (2002). The health impacts of exposure to indoor air pollution from solid fuels in developing countries: Knowledge, gaps, and data needs. *Environmental Health Perspectives*, 110(11), 1057-1068. <http://www.jstor.org/stable/3455428>

- Ezzati, M., Lopez, A.D., Rodgers, A., & Murray, C.J.L. (Eds.). (2004). Comparative Quantification of Health Risks: Global and regional burden of disease attributable to selected major risk factors (Vols. 1-2). Geneva: WHO. Retrieved from <http://www.who.int/publications/>
- Ezzati, M., Lopez, A.D., Rodgers, A., Hoorn, S.V., Murray, C.J.L., & the Comparative Risk Assessment Collaborating Group. (2002). Selected major risk factors and global and regional burden of disease. *The Lancet*, 360(2), 1347-1360. Retrieved from www.thelancet.com
- Farsi, M., Filippine, M., & Pachauri, S. (2007). Fuel choice in urban Indian households. *Environment and Development Economics*, 12(6), 757-774. doi:10.1017/S1355770X07003932.
- Fields Scott, (2006). 'Keeping the Home Fires Burning Cleaner: Solid Fuel Use, Health, and the Millennium Development Goal', *Environmental Health Perspectives* Vol. 114, No.3., National Institute of Environmental Health Sciences.
- Fullerton, D.G., Semple, S., Kalambo, F., Suseno, A., Malamba, R., Henderson, G., Gordon, S.B. (2009). Biomass fuel use and indoor air pollution in homes in Malawi. *Occupational and Environmental Medicine*, 66(11), 777-783. Retrieved from <http://www.jstor.org/stable/27797668>
- Gangopadhyay, S., Ramaswami, B., & Wadhwa, W. (2004). Reducing subsidies on household fuels in India: How will it affect the poor? *Energy Policy*, 33, 2326-2336. doi:10.1016/j.enpol.2004.04.024
- Global Alliance for Clean Cookstoves (GACC). (2011). Igniting change: A strategy for universal adoption of clean cookstoves and fuels. Washington: Author. Retrieved from www.cleancookstoves.org
- Goldemberg, J., Johansson, T.B., Reddy A.K.N., & Williams, R.H. (2004). A global clean cooking fuel initiative. *Energy for Sustainable Development*, 8(3), 5-12.
- Goodman, G.T. (1987). Biomass energy in developing countries: Problems and challenges. *Ambio, Forestry*, 16(2/3), 111-119. Retrieved from <http://www.jstor.org/stable/4313335>
- Gopinathan, M.C., & Sudhakaran, R. (2009). Biofuels: Opportunities and challenges in India. *In Vitro Cellular and Development Biology*, 45(3), 350-371. Retrieved from <http://www.jstor.org/stable/20541038>
- Government of India, (2006). 'National Environment Policy', Ministry of Environment and Forests.
- Government of India, Annual Report: (2014-2015), 'Energizing Growth of the Nation', Ministry of Petroleum and Natural Gas.
- Government of Sikkim, (2015). 'Sikkim Human Development Report 2014: Expanding Opportunities, Promoting Sustainability', New Delhi, India.
- Graham, N.M.H., (1990). The epidemiology of acute respiratory infections in children and adults: A global perspective. *Epidemiologic Review*, 12, 149-178. Retrieved from <http://epirev.oxfordjournals.org/>
- Grieshop, A.P., Marshall, J.D., & Kandlikar, M. (2011). Health and climate benefits of cookstove replacement options. *Energy Policy*, 39, 7530-7542. doi:10.1016/j.enpol.2011.03.024

- Gupta G. and Kohlin G. (2006). 'Preferences for domestic fuel: Analysis with socio-economic factors and rankings in Kolkata, India', *Ecological Economics* (57), 107–121, Elsevier.
- Gupta, B.N., Mathur, N., Mahendra, P.N., Srivastava, A.K., Swaroop, V., & Agnihotri, M.S. (1997). A study of household environmental risk factors pertaining to respiratory Diseases. *Energy Environmental Monitor*, 13, 61-67.
- Gupta, S., & Ravindranath, N.H. (1997). Financial analysis of cooking energy options for India. *Energy Conversion and Management*, 38(18), 1869-1876. Retrieved from <http://eprints.iisc.ernet.in/10705/>
- Hall, D.O. (1982). Biomass for energy: Fuels now and in the future. *Journal of the Royal Society of Arts*, 130(5312), 457-471. Retrieved from <http://www.jstor.org/stable/41373416>.
- Hanna R and Oliva P, (2013). 'Moving up the Energy Ladder: The Effect of an Increase in Economic Well-being on the Fuel Consumption Choices of the Poor in India'.
- Hassan M.K, Halder P, Pelkonen P and Pappinen A, (2013). 'Rural households' preferences and attitudes towards biomass fuels - results from a comprehensive field survey in Bangladesh', Hassan et al. *Energy, Sustainability and Society*.
- Heltberg, R. (2004). Fuel switching: Evidence from eight developing countries. *Energy Economics*, 26, 869-887. doi:10.1016/j.eneco.2004.04.018
- Heltberg, R. (2005). Factors determining household fuel choice in Guatemala. *Environment and Development Economics*, 337-361 doi:10.1017/S1355770X04001858
- Holdren, J.P., & Smith, K.R. (2000). Energy, the environment, and health. In Tord Kjellstrom, David Streets, & Xiaodong Wang, *World energy assessment: Energy and the challenge of sustainability* (pp. 61-110). New York, USA: UNDP.
- Horst and Hovorka. (2008). 'Reassessing the "energy ladder": Household energy use in Maun, Botswana', Elsevier.
- Infante-Rivard, C. (1993). Childhood asthma and indoor environmental risk factors. *American Journal of Epidemiology*, 137(8), 834-844. IESS, (2015): 'India Energy Security Scenarios 2047' Available at: indiaenergy.gov.in.
- International Energy Agency (IEA). (2006). *World energy outlook, 2006*. France: OECD/IEA. Retrieved from www.worldenergyoutlook.org
- International Energy Agency (IEA). (2012). *World energy outlook, 2012*. France: OECD/IEA. Retrieved from www.worldenergyoutlook.org
- International Energy Agency (IEA). (2013). *World energy outlook, 2013*. France: OECD/IEA. Retrieved from www.worldenergyoutlook.org
- International Energy Initiative, (2004). 'Report on the use of LPG as a domestic cooking fuel option in India'.
- International Institute for Population Sciences (IIPS), (2014). 'District Level Household and Facility Survey (DLHS-4)', 2012-13: India. Sikkim: Mumbai: IIPS.
- International Institute for Population Sciences (IIPS). (2007). *National Family Health Survey (NFHS-3), 2005-06: India: Volume I*. Mumbai: IIPS.
- International Institute for Population Sciences (IIPS). (2007). *National Family Health Survey (NFHS-3), 2005-06: India: Volume II*. Mumbai: IIPS. Jain, Abhishek, Poulami Choudhary and Karthik Ganesan (2015): 'Clean, Affordable and Sustainable Cooking Energy for India- Possibilities and Realities beyond LPG', New Delhi: Council on Energy, Environment and Water.

- Jain, Abhishek, Poulami Choudhary and Karthik Ganesan (2015): 'Clean, Affordable and Sustainable Cooking Energy for India- Possibilities and Realities beyond LPG', New Delhi: Council on Energy, Environment and Water.
- Jiang Land O'Neil B.C. (2009). 'Household Projections for Rural and Urban Areas of Major Regions of the World', International Institute for Applied Systems Analysis, Interim Report.
- Joon, V., Chandra, A., & Bhattacharya, M. (2009). Household energy consumption pattern and socio-cultural dimensions associated with it: A case study of rural Haryana, India. *Biomass and Bioenergy*, 33, 1509-1512. doi:10.1016/j.biombioe.2009.07.016
- Joyeux, R., & Ripple, R.D. (2005). Household energy consumption versus income and relative standard of living: A panel approach. *Energy Policy*, 35, 50-60. doi:10.1016/j.enpol.2005.10.012
- Khosla .R, Dukkupati S, Dubash N.K, Sreenivas A and Cohen B., (2013) 'Towards Methodologies for Multiple Objective-Based Energy and Climate Policy', vol 1 no 49, Economic and Political Weekly.
- Kishore, A., & Spears, D. (2012). Clean cooking fuel, women's intrahousehold status, and son preference in rural India. 1-19. Retrieved from <http://www.researchconnections.org>
- Kolappan, C., & Subramani, R. (2009). Association between biomass fuel and pulmonary tuberculosis: A nested case-control study. *Thorax*, 64(8), 705-708. Retrieved from <http://www.thorax.bmj.com>
- Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Delhi: New Age International Publishers.
- Lahoti R, Suchitra J Y, Goutam P, (2013). 'A Rejoinder on LPG Subsidies', Economic & Political Weekly, January 5, 2013 vol xl viII no 1.
- Lahoti, R., Suchitra, J.Y., & Goutam, P. (2012). Subsidies for whom? The case of LPG in India. *Economic and Political Weekly*, 47(44), 16-18.
- Lama S. and Devkota B., (2009), 'Vulnerability of mountain communities to climate change and adaptation strategies', Vol 10, *The Journal of Agriculture and Environment*.
- Lama, Mahendra P. 2001 '*Sikkim Human Development Report*', New Delhi: Esha Bétéille
- Leach, G. (1992). The Energy Transition. *Energy Policy*, 20(2), 116-123.
- Legros, G., Havet, I., Bruce, N., Bonjour, S. (2009). The energy access situation in developing countries. World Health Organization and UNDP. Retrieved from <http://www.who.int/indoorair/publications/energyaccesssituation/en/>
- Lehmann, J.Y.K., Chiquero, A.N., & Fernandez, M.V. (2012). Explaining the birth order effect: The role of prenatal and early childhood investment. IZA Discussion Paper No. 6755. Retrieved from <http://ssrn.com/abstract=2157897>
- Lewis, J.J., & Pattanayak, S.K. (2012). Who adopts improved fuels and cookstoves? A systematic review. *Environmental Health Perspectives*, 120(5), 637-645. Retrieved from <http://www.jstor.org/stable/41548659>
- Lin, H.H., Ezzati, M., & Murray, M. (2007). Tobacco smoke, indoor air pollution and tuberculosis: A systematic review and meta-analysis. *PLoS Med*, 4(1): e20. doi:10.1371/journal.pmed.0040020 .
- Link C.F, Axinn W.G and Ghimire D.J, (2012). 'Household energy consumption: Community context and the fuelwood transition', *Social Science Research* (41), 598–611, Elsevier.

- Lopez, A.D., Mathers, C.D., Ezzati, M., Jamison, D.T., & Murray, C.J.L. (2006a). Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. *The Lancet*, 367, 1747-1757. Retrieved from <http://www.thelancet.com>
- Lopez, A.D., Mathers, C.D., Ezzati, M., Jamison, D.T., & Murray, C.J.L. (Eds.) (2006b). *Global Burden of Disease and Risk Factors*. New York: World Bank/Oxford University Press.
- Lottes, I.L., DeMaris, A., & Adler, M.A. (1996). Using and interpreting logistic regression: A guide for teachers and students. *Teaching Sociology*, 24(3), 284-298. Retrieved from <http://www.jstor.org/stable/1318743>
- Masera, O.R., Saatkamp, B.D., & Kammen D.M. (2000). From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. *World Development*, 28(12), 2083-2103. doi:10.1016/S0305-750X(00)00076-0
- Mekonnen, A., & Kohlin, G. (2009). Determinants of household fuel choice in major cities in Ethiopia. Working Paper in Economics, University of Gothenburg. 1-18.
- Miah, Md.D., Kabir, R.R.M.S., Koike, M., Akther, S., & Shin, M.Y. (2009). Rural household energy consumption pattern in the disregarded villages of Bangladesh. *Energy Policy*, 38, 997-1003. doi:10.1016/j.enpol.2009.10.051
- Mishra Vinod K, Retherford Robert D and Smith Kirk R. (2014). 'Biomass Cooking Fuels and Prevalence of Tuberculosis in India'
- Mishra, V. (2003a). Effect of indoor air pollution from biomass combustion on prevalence of asthma in the elderly. *Environmental Health Perspectives*, 111(11), 71-77. Retrieved from <http://jstor.org/stable/3455723>
- Mishra, V. (2003b). Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe. *International Journal of Epidemiology*, 32, 847-853. doi:10.1093/ije.dyg240
- Mishra, V., Dai, X., & Smith, K.R. (2002). Indoor air pollution: The quiet killer. *Asia Pacific Issues*, 63, 1-8.
- Mishra, V., Dai, X., & Smith, K.R. (2004). Maternal exposure to biomass smoke and reduced birth weight in Zimbabwe. *Ann Epidemiol*, 14(10), 740-747. doi:10.1016/j.annepidem.2004.01.009
- Mishra, V., Retherford, R.D., & Smith, K.R. (2005a). Cooking smoke and tobacco smoke as risk factors for stillbirth. *International Journal of Environmental Health Research*, 15(6), 397-410. doi:10.1080/09603120500288913
- Mishra, V., Retherford, R.D., & Smith, K.R. (1999a). Cooking with biomass fuels increases the risk of blindness. *Journal of Environmental Medicine*, 1, 189-199.
- Mishra, V., Retherford, R.D., & Smith, K.R. (1999b). Biomass cooking fuels and prevalence of tuberculosis in India. *International Journal of Infectious Diseases*, 3(3), 119-129. doi:10.1016/S1201-9712(99)90032-2
- Mishra, V., Smith, K.R., & Retherford, R.D. (2005b). Effects of cooking smoke and environmental tobacco smoke on acute respiratory infections in young Indian children. *Population and Environment*, 26(5), 375-396. Retrieved from <http://www.jstor.org/stable/27503934>
- National Commission for Women. (2004). *Violence against women in north east India: An enquiry*. Report by The North East Network: New Delhi.

- Norman C, 1984: 'No Panacea for the Firewood Crisis', Science Series, Vol 226, No. 4675, p. 676, American Association for the Advancement of Science.
- Ogwumike, F.O., Ozughalu, U.M., & Abiona, G.A. (2014). Household energy use and determinants: Evidence from Nigeria. *International Journal of Energy Economics and Policy*, 4(2), 248-262. Retrieved from <http://www.econjournals.com>
- Oxford University Press, (2010). 'Human Development in India: Challenges for a society in Transition', New Delhi, India.
- Pachauri, S. (2003). An analysis of cross-sectional variations in total household energy requirements in India using micro survey data. *Energy Policy*, 32, 1723-1735. doi:10.1016/S0301-4215(03)00162-9
- Pachauri, S., & Jiang, L. (2008). The household energy transition in India and China. *Energy Policy*, 36, 4022-4035. doi:10.1016/j.enpol.2008.06.016
- Pachauri, S., & Spreng, D., (2004). Energy use and energy access in relation to poverty. *Economic and Political Weekly*, 39(3), 271-278.
- Pachauri, S., Mueller, A., Kemmler, A., & Spreng, D. (2004). On measuring energy poverty in Indian households. *World Development*, 32(12), 2083-2104. doi:10.1016/j.worlddev.2004.08.005
- Pandey, M.R. (1984). Domestic smoke pollution and chronic bronchitis in a rural community of the hill region of Nepal. *Thorax*, 39, 337-339. Retrieved from <http://www.thorax.bmj.com>
- Pandey, V.L., & Chaubal, A. (2011). Comprehending household cooking energy choice in rural India. *Biomass and Bioenergy*, 35, 4724-4731. doi:10.1016/j.biombioe.2011.09.020
- Parikh, J., & Laxmi, V. (2000). Biofuels, pollution and health linkages: A survey of rural Tamil Nadu. *Economic and Political Weekly*, 35(47), 4125-4137. Retrieved from <http://www.jstor.org/stable/4409979>
- Parikh, J., Biswas, H., & Karmakar, S. (2003). Cooking with Biofuels: Risk Factors Affecting Health Impact on Rural Women. *Economic and Political Weekly*, 38(26), 2681-2692.
- Parikka, M. (2004). Global biomass fuel resources. *Biomass and Bioenergy*, 27, 613-620. doi:10.1016/j.biombioe.2003.07.005
- Patel, V.J. (1985). Rational approach towards fuelwood crisis in rural India. *Economic and Political Weekly*, 20(32), 1366-1368.
- Patra, (2012). 'The Case of LPG', *Economic & Political Weekly*, December 8, 2012 vol xl viI no 49.
- Peng, C.Y.J., Lee, K.L., & Ingersoll, G.M. (2002). An introduction to logistic regression analysis and reporting. *The Journal of Educational Research*, 96(1), 3-14. Retrieved from <http://www.jstor.org/stable/27542407>
- Peng, C.Y.J., So, T.S.H., Stage, F.K., & John, E.P.S. (2002). The use and interpretation of logistic regression in higher education journals: 1988-1999, *Research in Higher Education*, 43(3), 259-293. Retrieved from <http://www.jstor.org/stable/40196455>
- Perez-Padilla, R., Perez-Guzman, C., Baez-Saldana, R., & Torres-Cruz, A. (2001). Cooking with biomass stove and tuberculosis: A case control study. *The International Journal of Tuberculosis and Lung Disease*, 5(5), 441-447.

- Perez-Padilla, R., Schilman, A., & Riojas-Rodriguez, H. (2010). Respiratory health effects of indoor air pollution. *The International Journal of Tuberculosis and Lung Disease*, 14(9), 1079-1086.
- Pokhrel, A.K., Bates, M.N., Verma, S.C., Joshi, H.S., Sreeramreddy, C.T., & Smith, K.R. (2010). Tuberculosis and indoor biomass and kerosene use in Nepal: A case-control study. *Environmental Health Perspectives*, 118(4), 558-564. Retrieved from <http://www.jstor.org/stable/25653848>
- Rao, M.N., & Reddy, B.S. (2006). Variations in energy use by Indian households: An analysis of micro level data. *Energy*, 32, 143-153. doi:10.1016/j.energy.2006.03.012
- Ravindranath, N.H., & Ramakrishna, J. (1997). Energy options for cooking in India. *Energy Policy*, 25(1), 63-75. doi:10.1016/S0301-4215(96)00105-X
- Ravindranath, Sharma, Sagadevan, Jayaraman, Munsu, (2012). "Climate change and its impact on forests of Sikkim" edited by M. L. Arrawatia, Sandeep Tambe, 'Climate Change in Sikkim- Patterns, impacts and initiatives', IPR, Government of Sikkim.
- Reddy, B.S., & Balachandra, P. (2002-2003). A sustainable Energy Strategy for India Revisited. *Economic and Political Weekly*, 37(52), 5264-5273.
- Rehfuess, E.A., Bruce, N., & Smith, K.R. (2011). Solid fuel use: Health effect. In Nriagu J.O. (Ed.), *Encyclopedia of environmental health*, vol. 3 (pp. 150-161). Burlington: Elsevier.
- Rehfuess, E.A., Mehta, S., & Pruss-Ustun, A. (2006). Assessing household solid fuel use: Multiple implications for the Millennium Development Goals. *Environmental Health Perspectives*, 114(3), 373-378. Retrieved from <http://www.jstor.org/stable/3436680>
- Risley H.H, 2001, ' *The Gazetteer of Sikkim*', *Low Price Publication* (Reprint), New Delhi.
- Romijn, H., Raven, R., & Visser, I. (2010). Biomass energy experiments in rural India: Insights from learning-based development approaches and lessons for strategic niche management. *Environmental Science & Policy*, 13, 326-338. doi:10.1016/j.envsci.2010.03.006
- Ruijven, B.J.V., Vuuren, D.P.V., Vries, B.J.M.D., Isaac, M., Sluijs, J.P.V.D., Lucas, P.L., & Balachandra, P. (2011). Model projections for household energy use in India. *Energy Policy*, 39, 7747-7761. doi:10.1016/j.enpol.2011.09.021
- Saha, A., Kulkarni, P.K., Shah, A., Patel, M., & Saiyed, H.N. (2005). Ocular morbidity and fuel use: An experience from India. *Occupational and Environmental Medicine*, 62(1), 66-69. Retrieved from <http://www.jstor.org/stable/27732446>
- Sanbata. Habtamu, Asfaw Araya and Kumie Abera, (2014). 'Association of biomass fuel use with acute respiratory infections among under- five children in a slum urban of Addis Ababa, Ethiopia', *BMC Public Health*, 14:1122.
- Sauerborn R., Adams A. and Hien M. (1996) 'Household strategies to cope with the Economic costs of illness', *Sos. Sc. Med.* Vol. 43, No. 3, pp. 291-301.
- Shetty, N., Shemko, M., Vaz, M., & D'Souza, G. (2006). An epidemiological evaluation of risk factors for tuberculosis in South India: A matched case control study. *The International Journal of Tuberculosis and Lung Disease*, 10(1), 80-86.
- Shukla, P.R. (n.d). Biomass energy in India: Transition from tradition to modern. *The Social Engineer*, 6(2). Retrieved from <http://www.e2analytics.com>
- Siddiqui, A.R., Gold, E.B., Yang, X., Lee, K., Brown, K.H., & Bhutta, Z.A. (2008). Prenatal exposure to wood fuel smoke and low birth weight. *Environmental Health Perspectives*, 116(4), 543-549. <http://www.jstor.org/stable/40040111>

- Smeets M.W. E, Johnson X Francis and Tremeer G.B, (2012). ‘Keynote Introduction: Traditional and Improved Use of Biomass for Energy in Africa’, pp no, 3-12, edited by Janssen R and Rutz D ‘Bioenergy for Sustainable Development in Africa’.
- Smith, K.R., Samet, J.M., Romieu, I., & Bruce, N. (2000). Indoor air pollution in developing countries and acute lower respiratory infections in children. *Thorax*, 55, 518-532. Retrieved January 31, 2014, from <http://www.thorax.bmj.com>
- Smith, Kirk R et al (2014): “Millions Dead: How Do we know and what Does It Mean? Methods Used in the Comparative Risk Assessment of Household Air Pollution,” *Annual Review of Public Health*: 185–206.
- Srivastava, L., Goswami, A., Diljun, G.M., & Chaudhury, S. (2012). Energy access: Revelations from energy consumption patterns in rural India. *Energy Policy*, 47, 11-20. doi:10.1016/j.enpol.2012.03.030
- Stern D.I, (2004). ‘The Rise and Fall of the Environmental Kuznets Curve’, *World Development* Vol. 32, No. 8, pp. 1419–1439, Elsevier.
- Tambe and Arrawatia, (2012). ‘Climate Change initiatives in Sikkim’, edited by M. L. Arrawatia, Sandeep Tambe, ‘Climate Change in Sikkim- Patterns, impacts and initiatives’, IPR, Government of Sikkim.
- The World Bank, (2012). ‘Africa Clean Cooking Energy Solutions Initiative (ACCES)’, Washington, D.C. 20433, U.S.A.
- Treiber M.U, Grimsby L.K and Aune J.B, (2015). ‘Reducing energy poverty through increasing choice of fuels and stoves in Kenya: Complementing the multiple fuel model’, *Energy for Sustainable Development* (27) 54–62, Elsevier.
- UNDP. (2000). *World energy assessment: Energy and the challenge of sustainability*. New York, USA: UNDP
- UNDP. *Human Development Report* (2013), ‘The Rise of the South: Human Progress in a Diverse World’.
- UNICEF, WHO (2006). *Pneumonia: The forgotten killer of children*. UNICEF/WHO. Retrieved from <http://www.unicefinnovation.org>
- Venkataraman, C., Sagar, A.D., Habib, G., Lam, N., & Smith, K.R. (2010). The Indian national initiative for advanced biomass cookstoves: The benefits of clean combustion. *Energy for Sustainable Development*, 14, 63-72. doi:10.1016/j.esd.2010.04.005
- Viswanathan, B., & Kumar, K.S.K. (2003). Cooking fuel use patterns in India: 1983-2000. *Energy Policy*, 33, 1021-1036. doi:10.1016/j.enpol.2003.11.002.
- Wangchuk S, Siebert S and Belsky J. (2013). ‘Fuel wood Use and Availability in Bhutan: Implications for National Policy and Local Forest Management’, *Human Ecology*, 42:127–135, Springer. White C. J, 1971, ‘*Sikkim and Bhutan: Twenty one in the north-east frontier 1887-1908*’, Gupta L R Vivek Pub Home, New Delhi.
- White C. J, 1971, ‘*Sikkim and Bhutan: Twenty one in the north-east frontier 1887-1908*’, Gupta L R Vivek Pub Home, New Delhi.
- World Bank (2003). ‘Household fuel and energy use in developing countries- A multicountry study’.
- World Bank, (2002), ‘India, household energy, Indoor air pollution and health’, Joint UNDP/ (ESMAP).
- World Health Organization (WHO). (2006). *Fuel for life: Household energy and health*. France: WHO.

- World Health Organization (WHO). (2006). The world health report 2006: Working together for health. Switzerland: WHO
- World Health Organization (WHO). (2006). World health statistics 2006. Switzerland: WHO
- World Health Organization (WHO). (2008). The Global Burden of Disease: 2004 Update. Switzerland: WHO.
- World Health Organization (WHO). (2008). World health statistics 2008. France: WHO
- World Health Organization (WHO). (2010). World health statistics 2010. France: WHO
- World Health Organization (WHO). (2013). World health statistics 2013. Italy: WHO
- World Health Organization . (2005). Indoor air pollution from solid fuels and risk of low birth weight and stillbirth. Report from a Symposium Held at the Annual Conference of the International Society for Environmental Epidemiology (ISEE). Switzerland: WHO.
- World Resources Institute/United Nations Environment Programme/UNDP/World Bank. (1998). World resources, 1998-99. New York: Oxford University Press.
- Zigova K., Fuchs R., Jiang L., C. O'Neill B. and Pachauri S. (2009). 'Household Survey Data Used in Calibrating the Population-Environment-Technology Model', International Institute for Applied Systems Analysis, Interim Report.

APPENDIX

1. Percentage of various fuel use in across districts of Sikkim (Rural), 2001-2011

	2001 (Rural)				2011 (Rural)				
	<i>Firewood</i>	<i>Kerosene</i>	<i>LPG</i>	<i>Electricity</i>	<i>Firewood</i>	<i>Kerosene</i>	<i>LPG</i>	<i>Electricity</i>	
North	78.33	12.87	6.17	0.11	North	70.9	4.2	20.5	0.2
West	86.34	5.16	7.1	0.1	West	80	1.5	16.7	0
South	75.09	9.64	11.88	1.89	South	72.3	2	23.7	0.7
East	62.57	18.33	17.52	0.05	East	62	4.4	32	0.3
Sikkim	73.25	12.21	12.43	0.57	Sikkim	70.8	2.9	24.3	0.3
Total	64.6	14.51	18.83	0.5	Total	52.5	4.4	41.3	0.3

2. Percentage of various fuel use in across districts of Sikkim (Urban), 2001-2011

	2001 (Urban)				2011 (Urban)				
	<i>Firewood</i>	<i>Kerosene</i>	<i>LPG</i>	<i>Electricity</i>	<i>Firewood</i>	<i>Kerosene</i>	<i>LPG</i>	<i>Electricity</i>	
North	1.46	43.57	38.89	0	North	8	15.8	75.1	0.1
West	25.46	27.56	40.42	0	West	12	8.7	76.8	0
South	3.63	25.78	69.71	0	South	6.2	8.9	83.4	0
East	2.97	30.81	65.01	0.02	East	4.8	8	86	0.1
Sikkim	3.63	30.74	63.9	0.02	Sikkim	5.3	8.3	85.1	0.1
Total	64.6	14.51	18.83	0.5	Total	52.5	4.4	41.3	0.3

3. Questionnaires:

This interview is exclusively for research purpose. Your name and other personal information will be retained in a confidential manner.

Name and signature of respondent:
Village Name, Block, Constituency
(CSRD)

Signature and date:
Depesh Subba (PhD Scholar)
Centre for the Study of Regional Development
School of Social Sciences (SSS-III)
Jawaharlal Nehru University (JNU), New Delhi

HOUSEHOLD QUESTIONNAIRE

1. **Name of the respondent:**
2. **Name of household head:**
3. **Religion of the household:**
 - i. Hinduism =1
 - ii. Buddhism =4
 - iii. Christianity =3
 - iv. Other (specify)=5
4. **Social category of household (caste):**
 - i. Scheduled Tribes=1
 - ii. Scheduled Castes=2
 - iii. Other Backward Classes=3
 - iv. Others (specify)=4

5. **Family type:** Nuclear=1, Joint=2, Single=4

6. HOUSEHOLD SCHEDULE:

Sl. No	Household Members	Relationship to household head	Gender	Age	Education	Marital status*	Occupation@	Nature of work \$	Status of work #
1									
2									
3									

* marital status: never married =1, currently married =2, widowed =3, divorced/separated = 4

@ Farmer=1, Agricultural labour=2, Non agriculture Labourer/Wage labor=3, Private service, Self-employed, Artisan/independent work or Carpenter=4, Contractor=5, Govt.salaried/pensioner=6, other (specify)=7

\$ Agriculture=1, Non-agriculture=2

Seasonal=1, Full year=2, Permanent=3

7. Education level of children:

Name	Class	Gender	Age	Institution type		Distance from house	Education level of parents	
				Govt.	Private		Father	Mother

8. Economic activities, income and expenditure of household (monthly):

Economic activities (p)	Earnings (in Rs.)	Expenditure (in Rs.)		Remark
i.				
ii.				
iii.				
Total				

(p) = Principal source of income

9. Ownership status:

	Code	Remark
i. Nature of house \$		
ii. House type %		
iii. Ownership status of this house @		
iv. Whether owns any land? #		
a. If 'yes' &		
i. Does this household cultivate any agricultural land in last year? #		
ii. Does your household own any livestock/animals? #		
b. If 'yes'		Specify animals:
iii. How much agricultural land do members of this household own?	In acres:	

\$ Permanent=1, Temporary=3 %

Pucca=1, Semi-pacca=2, Kuchha=3

@ Owned=1, Rented=2, Any other=3

#Yes=1, No=2,

&Agricultural land=1, Non-agricultural land=2

10. Number of rooms:

11. Predominant materials of floor, wall and roof of the house:

Material	Code	Remark
Floor*		
Wall @		
Roof #		

*Mud=1, wood/bamboo=2, Stone=3, Cement=4, Floor tiles=5, Any other=6

@ Grass/thatch/bamboo etc=1, Plastic/polythene=2, mud/unburnt brick=3, wood=4, Stone not packed with mortal=5, Stone not packed with mortal=6, G.I./metal/asbestos sheets=7, Burnt brick=8, Concrete =9, Any other=10

Grass/thatch/bamboo/wood/mud etc=1, Plastic/polythene=2, Hand made tiles=3, Machine made tiles=4, Burnt brick=5, Stone=6, Slate=7, G.I./metal/asbestos sheets=8, Concrete =9, Any other=10

12. House accessible by road:

- i. Pucca road=1
- ii. Kachha road=2
- iii. Footpath only=3

13. Distance from house to road. In Kilometer=

14. Road type and year of road accessible =

15. Is this road useable during monsoon? Yes=1, No=2

16. Whether any member of household has migrated? If 'yes'

Name	Age	Gender	Education	Occupation	Place & duration	Remittances	Frequency of visit	

17. Household assets and banking:

i.	Radio/transistor	Code*	Remark
ii.	Television		
iii.	Computer/Laptop		
iv.	Telephone/Mobile		
v.	Scooter/Motorcycle		
vi.	Car/Jeep/Van		
vii.	Availing banking services		
viii.	Internet facility		
ix.	Other (specify)		

*Yes=1, No=2

18. Does any member of household have following:

Documents	Code*	Financial accounts	Code*	Remark
BPL card		Bank account		
APL card		Cooperative bank		
Aadhar card		Post office account		
Certificate of Identification/Domicile		SHGs/ Bandhan		
MGNEGRA/Job card				

*Yes=1, No=2

19. Are you aware of Aadhar / Unique ID Number/program? Yes=1, No=2

a. If 'no' to Aadhar card, what is the main reason for not having an Aadhar card?

- i. Not needed=1
- ii. Lost=2
- iii. Bureaucratic difficulties=3
- iv. Moved but not transferred=4
- v. Other (specify)=5

20. Source of loan at last moment/emergency:

- i. Money lender=1
- ii. Relatives=2
- iii. Cooperative/SHGs/ Bandhan=3
- iv. Banks=4
- v. Other (specify)=5

21. Does this house have electricity? Yes=1, No=2, If 'yes', since when?(year)=

22. If yes, how many hours per day do you generally have power? Hours=

23 Frequency of power supply:

- i. Regular=1
- ii. Irregular=2

24. **Whether there are seasonal (summer and winter) disturbances in power supply?** *Yes=1, No=2*

25. **Whether is subsidized electricity or not?** *Yes=1, No=2*

26. **How much did you pay for it last month?** In Rs=

27. **Does the household use electricity in?**

	Code*	If yes, how often@	Remark
Cooking food			
Heating			

**Yes=1, No=2*

@*Regularly=1, Sometimes=2, Never=3*

28. **Are you aware about the government's social schemes?** *Yes=1, No=2*

i. If 'yes' sources:

29. **Are you getting benefit of social schemes (PDS) as per rule and regulation/policy?** *Yes=1, No=2*

i. If 'no', mention reasons/problems:

30. **Have you ever use internet to get information about Govt. schemes?** *Yes=1, No=2*

31. **How often people in the household:**

	Code*	Men	Women	Children	Remark
i. Listen to the radio					
ii. Read newspapers					
iii. Watch TV					
iv. Watch news, educational or agricultural programmes on TV					

* *Regularly=1, Sometimes=2, Never=3*

32.

	Code*	Men/Women	Remark
1. Does anybody in the household belong to a			
i. Self Help Groups			
ii. Credit or savings group			
iii. Development group or NGO			
iv. Agricultural or other co-operative			
v. Political organization			
vi. Other			
2. Does any woman member of the household have			
i. Bank account			
ii. Aadhar/UID card			
iii. Health insurance/card			
iv. BPL card			
v. Voter card			
vi. MGREGRA/Job card			

**Yes=1, No=2*

33. **Is any household member attended a public meeting called by the village / ward committee in the last year?** *Yes=1, No=2*

a. If 'yes', how often:

i. Regularly=1

ii. Sometimes=2

34. Compared to 5 years ago, would you say your household is economically doing the same, better or worse today?

- i. Same= 1
- ii. Better= 2
- iii. Worse= 3

HOUSEHOLD COOKING FUEL USE:

35. Availability of kitchen:

- i. Cooking inside house:
 - a. Has kitchen=1,
 - b. Does not have kitchen=2
- ii. Cooking outside house-:
 - a. Has kitchen=1
 - b. Does not have kitchen=2

36. Type of fire/stove among households using solid fuels:

- i. Open fire/*chullah* under a chimney
- ii. Open fire/*chullah* not under a chimney

37. Who usually take the household decision on?

	Code*	Remark
i.	Financial Affairs	
ii.	Health care	
iii.	Major household purchase	
iv.	Purchase of daily household needs	
v.	Household cooking fuel	

*Code: wife=1, husband=2, Wife and husband jointly=3, Other (specify)= 4

38. Primary source of energy for lightening and cooking:

Primary source of energy for				Reasons behind selecting a particular or mixed fuel type
Lightening*		Cooking#		
	Code		Code	
Electricity		Firewood		
Kerosene		Kerosene		
Solar		Biogas		
Mixed		LPG		
Other		Electricity		
		Mixed		
		Other		

*Code for Lightening: Electricity-1, Kerosene- 2, Solar- 3, Mixed- 4, Other-5

#Code for Cooking: Firewood-1, Kerosene -2, Biogas -3, LPG-4, Electricity-5, Mixed-6, Other-7

39. Household on the basis of cooking fuel use:

- i. the household consumes only solid fuel(s)=1
- ii. the household consumes both solid and non-solid fuels=2
- iii. the household consumes only non-solid fuel(s)=3

40. Fuel type: It's uses, source and consumption during the last 1 year (focus on seasonal variation)

1. Does your household use firewood?				Quantity (month)	Value/Price (in Rs)
For what purpose is it mainly used?	Fuel not used = 1	Where do you get most of firewood	Purchase=1	IF PURCHASE D – How much did you pay for what you used last month in	
	Mainly cooking = 2		Collect from own land=2		
	Mainly lighting = 3		Collect from village=3		
	Mainly heating = 4		Both=4		
	Combination = 5				
2. Does your household use Kerosene?					
For what purpose is it mainly used?	Fuel not used = 1	Where do you get most of kerosene		IF PURCHASE D – How much did you pay for what you used last month in	
	Mainly cooking = 2		Ration shop=1		
	Mainly lighting = 3		Market=2		
	Mainly heating = 4		Both=3		
	Combination = 5				
3. Does your household use LPG? If 'yes', year =					
For what purpose is it mainly used?	Fuel not used = 1	Where do you get most of LPG		IF PURCHASE D – How much did you pay for what you used last month in	
	Mainly cooking = 2		Subsidized government program = 1		
	Mainly lighting = 3		Gas Company=2		
	Mainly heating = 4		Black Market=3		
	Combination = 5				

41. How many meals, including breakfast are usually taken per day in your family? Mention=

42. Approximately how many hours is the stove burning in your household, including cooking heating water, making tea, etc.? Hours=

43. Food consumption pattern of household:

Food Items	Quantity	2.Vegetables/meat items	Quantity	Remark
	(frequency unit)		(frequency unit)	

44. Non-food fuel use:

- i. Same for both (food and non food items)=1
- ii. Different for food and non-food consumption=2

45. Consumption of fuel: Non-food items:

List of non-food items	Value (unit)	Remark
Lighting		
Heating		
Fodder		
Agriculture		
Animal		
Other (specify)		

46. **Who usually cook in household?**

- i. Women=1
- ii. Man=2
- iii. Other (specify)=3

47. **Whether head of the household, person who usually cooks and take decision on household cooking fuel are same? If 'no', specify:**

48. **Education level of:**

- i. Person who usually cooks in household=
- ii. Person who makes decision on cooking fuel=

49

	Code#	Remark
i.		What kind of oven are you currently using cooking food?*
ii.		Does a kitchen have improved chimney?
iii.		Is there a window or vent in the cooking area?
iv.		Are you aware about the uses LPG/induction cooking system?
v.		Is it possible to afford LPG from your income?
vi.		Did your household receive Smokeless/ improved Chula and LPG from the government?
vii.		Did your household receive Induction from the government?
viii.		Did your household receive biogas plant from the government?

* Traditional chulla-1, Improved chulla-2, Kerosene stove-3, Biogas oven-4, Gas stove-5, Induction-6
#Yes-1, No-2

50. **Energy saving devices/modern Cooking and Household Appliances of household:**

Appliances	Code*	Appliances	Code*	Appliances	Code*	Appliances
Stove, gas burner		Heater		Washing machine		Lantern
Rice cooker		Electric water Boiler		Water purifier		Power saving bulb (LED)
Pressure cooker		Fridge/ refrigerator		Electric iron (clothing)		Thermos or flask
Induction		Mixer / Grinder		Electric lamp		Oven

Yes=1, No=2

Other electric heating appliances (specify):

LPG user:

51.

	Value# (unit)	Remark
		Start-up cost of LPG connection including stove
		How much distances have to travel to get LPG cylinder?
		Whether there is fixed timing of LPG cylinder distribution or not
		LPG cylinder distribution frequency:*
		Whether LPG is easily obtained when in need?
		Time required to get filled LPG
		Are there any difficulties in getting LPG in time
		If 'yes', plz specify:

*Weekly=1, Once in a month=2, Twice in a month=3, Other (specify)=4

#Yes=1, No=2

52. Does anybody in the house or person who usually cooks know about the use of modern cook stoves? (Elaborate): Yes=1, No=2
53. Grievances regarding LPG cylinder distribution system, if any:
54. What would be the best solution in your opinion?
55. If household completely depends on LPG for cooking food what are the driving forces behind it?

Firewood user:

56. If still depended on firewood/kerosene for cooking fuel, what are the reasons? Mention=
57. Collection of firewood from:
- i. Reserve forest=1
 - ii. community forest=2
 - iii. Private forest=3,
 - iv. All=4
58. What is the distance to the nearest forest from your home? In km=
59. Does your household depend on any other forest product than firewood? If 'yes' mention:
60. Who usually collects the firewood for your household?
- i. Man=1
 - ii. Woman=2
 - iii. Boy children=3
 - iv. Girl children=4
 - v. Other=5
61. How long does it take to go there, get/collect firewood, and come back in one trip? Time=
62. Whether there is seasonal variation (summer-winter) of fuel consumption: Yes=1, No=2
63. Firewood collection according to source and time spent: How much total time weekly do.....

	Source*	Time spent	Quantity (week)	Seasonal variation		Remark
		(minute)		Summer	Winter	
i.	Adult women older than 15 years of age	spend collecting fuel?				
ii.	Adult men older than 15 years of age	spend collecting fuel?				
iii.	Girls under 15 years of age	spend collecting fuel?				
iv.	Boys under 15 years of age	spend collecting fuel?				

* Public forest=1, Private forest/pasture=2, Purchase=3, All=4, Other=5

64. What are the usual firewood collection practices?
- i. Collect dead wood=1
 - ii. Cut old branches of trees=2
 - iii. Cut tender branches of tree=3
 - iv. Fell old trees=4
 - v. Cut tender trees=5
65. Are you getting difficulties to find firewood/other forest resources from public forest these days?
- i. Firewood: Yes =1, No=2
 - ii. Other forest resources: Yes =1, No=2
 - a. If 'yes', mention reasons:
66. Whether conventional use of firewood has any religion or cultural significance? Yes=1, No=2, If 'yes' mention-
67. Whether there is any taste variation in cooked food on various fuels? Yes=1, No=2
If 'yes', elaborate:
68. Do you observe any changes in forest cover/area over the years? Yes=1, No=2

- a. If 'yes',
 - i. Increasing=1
 - ii. Decreasing=2
 - iii. No change=3
 - iv. Do not know=4

69. Are you aware about forest rules and regulations? Yes=1, No=2

70. Are you aware about JFM? Yes=1, No=2

71. Do you think that JFM /VDC/community/government has been able to protect/manage forest? Yes=1, No=2

72. What do you think about the management of forest by government? Elaborate:

73. Would you think forest conservation and protection is also your responsibility? Yes=1, No=2

- i. If 'yes', how would you contribute?

74. What are your previous participation/contributions? Mention=

75. Frequency of afforestation programme in village, if any (mention):

76. Frequency of forest officials visit in forest area:

77. Are there any specific forest rules in the village or adjacent forest area?

If 'yes', specify:

78. Suggestions to improve/conserves/manage forest: Mention=

79. Intervening factors in switching from firewood use to LPG/Electricity: List them:

80. Is there any taste variation in cooked food on various fuels? Yes=1, No=2

- i. If 'yes', elaborate:

81. Which fuel is convenient to use and why?

82. Fuel choice and reasons:

Fuel choice with reasons								Remark
LPG=1		Kerosene=2		Firewood=3		Mixed use=4		
Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	

Note: Positive and negative forces

83. The peoples' perceptions towards household cooking fuel:

Fuel	Rank	Availability	Affordability	Ease of Use	Efficiency	Pollution
Firewood	1					
	2					
LPG	1					
	2					
Kerosene	1					
	2					

84. Intervening factors in accessing household cooking fuels:

Fuel type	Factors			Remark
	Physical and Environmental	Economic & political	Socio-cultural	
Firewood				
Kerosene				
Bio-gas				
LPG				
Electricity				

85. Compared to 5 years ago, what would you say about household status in accessing cooking fuels today?

Fuels	Code#	Remark
Firewood		
Kerosene		
LPG		

same=1, better=2, worse=3

Health and gender aspect:

86.

Source of health care	Code*	Distance to nearest (in Km.)	Time required to travel (min)	Remark
1. Public health care				
i. Primary Health Centre (PHC)				
ii. District Hospital (DH)				
iii. Community Health Centre (CHC)				
2. Private clinic/hospital				
3. Other				

*PHC=1, DH=2, CHC=3, Private=4, Other=5

87. Does any member in the household have?

- i. Health insurance: *Yes=1, No=2*
- ii. LIC / life insurance: *Yes=1, No=2*
- iii. Other insurance (specify): *Yes=1, No=2*

88. Do you aware about the indoor air pollution resulting from the burning of firewood? *Yes=1, No=2*

89. Is smoke from a wood/dung burning traditional chulha good for health, harmful for health or do you think it doesn't really matter?

- i. Good=1
- ii. Harmful=2
- iii. Doesn't matter=3

90. Does any member from family is suffering from any following diseases (If the household have children under 5 year of age):

Disease symptoms	Children under 5 years*	Type	Chronic	Women (mother)*	Type	Chronic	Remark
		Acute			Acute		
i. Shortness/rapid/difficulty of breathing							
ii. Cough							
iii. Wheezing							
iv. Cold							
v. Poor visual (eye irritation)							

Yes=1, No=2

91. **Did any household member seek advice or treatment for the illness from any source?** *Yes=1, No=2*

- i. If *yes*, where did they seek advice or treatment? Specify=
- ii. Were any of these expenditures covered by the insurance/ such as mediclaim or RSBY? = *Yes=1, No=2*

92. **In the last 12 months, have you visited a doctor or other health care?** *Yes=1, No=*

93. **Women's access to money and credit, and their autonomy:**

	Code#	Remark
i. Women's access to money that they can decide how to use		
ii. Women's access to money that have a bank or savings account that they themselves use		
iii. Women who know of a microcredit programme		
iv. Women who have taken a loan from a microcredit programme		
Women can go to:*		
i. The market		
ii. The health facility		
iii. Places outside village/community		
iv. All three places		

#*Yes=1, No=2, and*

**Alone=1, with someone else only=2, Not at all=3*