

COMMUNITY PERCEPTION ON APPLICATION AND EFFECTS OF  
IMPROVED COOK STOVE: CONTRIBUTION TO ENVIRONMENT, HEALTH  
AND EDUCATION

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DECLARATION

I, hereby, declare that this dissertation has not been submitted for candidature for any other degree.

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## AN ABSTRACT OF THE DISSERTATION OF

*Binita Shrestha* for the degree of *Master of Education in Environment Education and Sustainable Development* entitled *Community Perception on Application and Effects of Improved Cook Stove: Contribution to Environment, Health and Education* was presented on 12 January, 2014 and

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Excessive dependency on traditional and commercial sources of energy has to be curtailed in order to prevent our society and country from the disastrous situation due to energy crisis in future. To prevent ourselves from being victim of energy crisis, renewable and alternative energy has to replace traditional and commercial sources of energy. With wide spread implementation of renewable energy technologies Improved Cook Stove (ICS) have become an important source of renewable energy for the rural poor. The use of Renewable Energy Technologies can reduce the dependency on traditional sources of energy, and help to protect the environment by reducing the emission of greenhouse gases which in turn can contribute in the protection of environment, in the maintenance of regional balance and in carrying out economic activities smoothly. It ultimately contributes to the improvement of health and education of the people. On this basis the study deals with community perception on effects of ICS, its contribution on children education and articulation of its effectiveness by ICS user.

The study aligns to post-positivist paradigm using quantitative method and is confined to ICS user only. For the study, questionnaire survey was conducted to

obtain the required data and information. Sample population of the study was 362. On the basis of sample, respondents were purposively selected from the sampling VDC and municipality of Kavrepalanchok District.

The study has revealed that ICS have positive effects on forest and environment conservation. The reduction in fuel wood consumption by ICS has important implications as it can conserve forest, thus, assuring greenery. Women are mainly responsible for cooking activities and collecting firewood. The study reports that ICS has reduced fuel wood consumption and is less time consuming. It has contributed the drudgery reduction of women by cutting down their cooking time and hardship in collection of scarce fuel wood. Furthermore, the use of ICS has supported in deforestation minimization and reduction of indoor air pollution. Women and their children are generally exposed to indoor air pollution. The indoor air pollution due to the combustion of biomass fuel is the main cause of Chronic Obstructive Pulmonary Disease, headache and eye infection in women and children. Study has shown that with the use of ICS human exposure to pollutants in the kitchen environment has been reduced. Furthermore, the use of ICS has contributed on education of children. It has motivated children to study and has improved their health as well by making the indoor air fresh.

The efforts by government should be directed towards the large scale dissemination of technology as there is huge potential of ICS in rural areas. Research and development by universities and other research organizations should be conducted to modify the design of ICS for increased efficiency to ensure the sustainability of the technology.

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## TABLE OF CONTENTS

AN ABSTRACT OF THE DISSERTATION .....	iv
ACKNOWLEDGEMENTS .....	vi
TABLE OF CONTENTS.....	viii
LIST OF FIGURES .....	xii
LIST OF ABBREVIATIONS .....	xv
CHAPTER I .....	1
INTRODUCTION.....	1
Chapter Overview .....	1
Background.....	1
Statement of the Problem .....	2
Purpose of the Study .....	3
Research Questions .....	4
Importance of the Study .....	4
Organization of the Study.....	5
Chapter Summary .....	5
CHAPTER II.....	6
LITERATURE REVIEW .....	6
Chapter Overview .....	6
Background.....	6
Renewable Energy.....	6
Renewable Energy Technology (RETs) .....	7
Improved Cook Stove .....	8
History of ICS in Nepal .....	8
Energy Scenario of Nepal .....	9
Potential of Renewable Energy Technology in Nepal .....	11
Subsidy Provision on RET.....	13

Subsidy Provision for ICS .....	13
Overview of Technical Support and Networking of RE Institutions for RE Institutions for Renewable Energy Service Deployment.....	14
Effects of Renewable Energy Technology .....	16
Contribution of Renewable Energy Technology on Children Education.....	17
Indoor Air Pollution (IAP) in Developing Countries .....	19
Health Effects of Indoor Air pollution .....	19
Theoretical Review .....	20
Sustainable Development Theory .....	20
Sustainable Natural Resource Conservation Theory .....	21
Past Study Review .....	22
Participatory Performance/ Impact Monitoring Report on ICS Program.....	22
Impact Study of ICS in Ghhaimale VDC of Kathmandu .....	25
A Comparative Study on Indoor Air Pollution of ICS vs. TCS.....	25
The Cleaner Energy Options for Indoor Air Pollution Control in Rural India ....	26
Indoor Air Pollution: The Case of Pakistan .....	27
Education for All.....	27
Country Education Programme in Nepal.....	29
Conceptual Framework .....	30
Chapter Summary .....	30
CHAPTER III.....	32
METHODOLOGY .....	32
Chapter Overview .....	32
Research Design .....	32
Study Area .....	33
Instrumentation .....	34
Sampling Design.....	34

Data Source .....	36
Tools and Techniques of Data Collection .....	36
Data Analysis and Interpretation .....	37
Reliability and Validity .....	38
Ethical Consideration .....	41
Schematic Representation of the Methodology Applied for the Dissertation .....	42
Chapter Summary .....	42
CHAPTER IV .....	44
RESULTS AND DISCUSSION .....	44
Chapter Overview .....	44
Socio-Economic Status of Study Area .....	44
Energy Scenario in Study Area.....	46
Findings in Respective VDC and Municipality.....	47
Respondents Perception on RETs.....	50
People’s Perception about the Effect of ICS on Environment .....	57
People’s Perception about the Effects of ICS on Health of People .....	58
Contribution of ICS on Children Education.....	60
People’s Perception and Articulation on Effectiveness of ICS .....	62
Chapter Summary .....	63
CHAPTER V.....	64
SUMMARY OF FINDING, DISCUSSION, CONCLUSION AND RECOMMENDATION .....	64
Chapter Overview .....	64
Key Findings.....	64
Discussion of Findings .....	66
Conclusion.....	69
Recommendation .....	71

Chapter Summary .....	72
References .....	73
ANNEX A: RESEARCH QUESTIONNAIRE.....	77
ANNEX B: RESEARCH OBJECTIVES .....	90
ANNEX C: DISSERTATION DATA.....	91
ANNEX D: DISSERTATION DATA REPRESENTATION ON TABLE .....	94
ANNEX E: PHOTOS .....	95

## LIST OF FIGURES

Figure 1. Sectoral Energy Consumption in Nepal (2008/09).....	10
Figure 2. Networking of Institutions of RE Deployment .....	14
Figure 3. The impact of ICS in different aspects. ....	23
Figure 4. Conceptual framework.....	30
Figure 5. Sampling Area of Kavrepalanchok District .....	33
Figure 6. Schematic representation of the methodology for the dissertation. ....	42
Figure 7. Sampling household types .....	47
Figure 8. Wall types.....	48
Figure 9. Contribution of ICS on children education.....	60

## LIST OF TABLES

Table 1 .....	7
Renewable energy sources and corresponding RETs.....	7
Table 2 .....	11
Total Sectoral Energy Consumption in 2010/11 in Kavrepalanchok.....	11
Table 3 .....	26
Health and economic benefits of biogas plant project.....	26
Table 4 .....	34
Effects of Improved Cook Stove on environment, health and education .....	34
Table 5 .....	36
Sampling HH number for Questionnaire Survey .....	36
Table 6 .....	39
Values and reliability scales for alpha coefficient.....	39
Table 7 .....	45
Education Status.....	45
Table 8 .....	45
Occupational Status .....	45
Table 9 .....	46
Energy consumption per month for different HH activities in study area.....	46
Table 10 .....	49
Sources of Firewood.....	49
Table 11 .....	50
Reduction in Fuelwood Consumption by ICS .....	50
Table 12 .....	50
Understanding of RETs .....	50
Table 13 .....	51
Response on Familiarity of Types of RETs.....	51

Table 14 .....	52
Types of Stove Used Before ICS and Types of Stove Used at Present .....	52
Table 15 .....	53
Reasons for Shifting from Other Stove to ICS.....	53
Table 16 .....	54
Maintenance of Stove by Respondents.....	54
Table 17 .....	55
Provision for Smoke Going Out of Kitchen .....	55
Table 18 .....	56
Satisfaction Level of User.....	56
Table 19 .....	57
Effects of ICS on Forest and Environment Conservation.....	57
Table 20 .....	58
Illness Caused by Smoke from Indoor Air Pollution and the Sufferer of it .....	58
Table 21 .....	59
People’s Perception about the Changes or Improvement in Health Problem after ICS Installation.....	59
Table 22 .....	61
Effects of ICS on Children Education .....	61
Table 23 .....	62
Respondent Articulation on Effectiveness of ICS.....	62

## LIST OF ABBREVIATIONS

ADB/N:	Agriculture Development Bank
AEPC:	Alternative energy Promotion Center
ARI:	Acute Respiratory Infection
BA:	Bachelor of Arts
B.S.:	Bikram Sambat
BSP:	Biogas Support Programme
<sup>0</sup> C:	Degree Celsius
CBS:	Center of Bureau Statistics
CF:	Community Forest
CFC:	Chloro Fluoro Carbon
CFDP:	Community Forestry Development Project
CO:	Carbon monoxide
CO <sub>2</sub> :	Carbon dioxide
COPD:	Chronic Obstructive Pulmonary Disease
CRT:	Center for Rural Technology
DDC:	District Development Committee
DEES:	District Energy and Environment Section
ECD:	Early Childhood Development
ENPHO:	Environment and Public Health Organization
ESAP:	Energy Sector Assistance Programme
FUG:	Forest User Group
FY:	Fiscal Year
GHG:	Green House Gas
GJ:	Giga Joule
GoN:	Government of Nepal
GW:	Giga Watt
GWh:	Giga Watt hour
Ha:	Hectare
HEI:	Human Empowerment Index
HH:	Household
HLEFFDP:	Hills Leasehold Forestry and Forage Development Project
HO:	Hand Over



IA:	Intermediate of Arts
IAP:	Indoor Air Pollution
ICS:	Improved Cook Stove
IICS:	Institutional Improved Cook Stove
INGOs:	International Non-government Organization
kWh/HH:	Kilowatt hour/Household
LFLP:	Leasehold Forestry and Livestock Program
LPG:	Liquidified Petroleum Gas
MA:	Master of Arts
MDG:	Millennium Development Goals
MICS:	Metallic Improved Cook Stove
MJ:	Mega Joule
MoF:	Ministry of Finance
mm:	Millimeter
MoSTE:	Ministry of Science, Technology and Environment
MPhil:	Master of Philosophy
MPFS:	Master Plan for the Forest Sector
MSL:	Mean Sea Level
Mt:	Metric tonnes
MW:	Mega Watt
NEA:	Nepal Electricity Authority
NGOs:	Non-government Organization
NP:	Nagarpalika
NPC:	National Planning Commission
NRs:	Nepali Rupees
PCL:	Proficiency Certificate Level
PhD:	Doctorate of Philosophy
PM:	Particulate Matter
PV:	Photo Voltaic
RCUP:	Resource Conservation and Utilization Project
RE:	Renewable Energy
RECAST:	Research Center for Applied Science and Technology
REMREC:	Resource management and Rural Empowerment Center
RETs:	Renewable Energy Technologies

RRESC:	Regional Renewable Energy Service Center
SFDP:	Small Farmer Development Project
SHS:	Solar Home System
SLC:	School Leaving Certificate
SPSS:	Statistical Package for Social Science
TCFDP:	Terai Community Forestry Development Project
TCS:	Traditional Cook Stove
VDCs:	Village Development Committees
WHO:	World Health Organization
UMN:	United Mission to Nepal
UNDP:	United Nation Development Program
UNESCO:	United Nation Educational, Scientific and Cultural Organization
UNICEF:	United Nation Children's Fund

## CHAPTER I

### INTRODUCTION

#### **Chapter Overview**

This chapter describes the background information on energy and its requirements in daily life. Furthermore, Chapter I include the total energy consumption in Nepal, statement of the problem, rationale of the study, purpose of the study, research questions related with the study, limitations of the study and organization of the study and finally the summary of the chapter. The main purpose of this chapter is to acquaint the readers with the intent of the study.

#### **Background**

Energy is fundamental to the quality of our lives. Nowadays, we are totally dependent on an abundant and uninterrupted supply of energy for living and working. It is a key ingredient in all sectors of modern economies. We know that energy demand will increase significantly in the future. How, then, will we satisfy this huge energy requirement in an environmentally friendly way? We use it constantly at home, at work and for leisure. In every activity at home and at workplace energy is used in the form of electrical energy, heat energy, light energy and mechanical energy. Energy maintains our standard of living and economy. We use energy daily to provide heat and electricity in our homes for light, domestic appliances, televisions, computers, etc. We use electricity in factories as well to power the manufacture of the products and in cars, trucks, ships and aeroplanes to transport people and goods.

Energy is the basic requirements of life. It changes from one form to other. Adequate and consistent development of usable energy sources is one of the prerequisites for social and economic development of a country. Generally in Nepal,

the notion of providing energy even to meet basic needs has been a big challenge mainly because of poor infrastructural development and lack of fund for investment in the energy generation and management (NRC, 2008). Therefore, Nepal has one of the lowest per capita energy consumption in the world and energy resources utilized mostly come from firewood.

Improving energy efficiency is a key strategy in making the world's energy system more economically and environmentally sustainable. The importance of energy efficiency has grown dramatically in recent years due to global climate change commitments, regional trade and investment pacts, local environmental issues, and widespread recognition of the need for sustainable development (Gurung, Gurung, & Oh, 2011).

Nepal relies heavily on traditional energy resources. The total energy consumption in Nepal for the year 2008/09 was about 9.3 million tonnes of oil equivalent (401 million GJ) out of which 87 % were derived from traditional resources, 12 % from commercial sources and less than 1 % from the alternative sources (WECS, 2010). Though well-endowed with abundant biomass and hydropower potential, no efforts to provide efficient energy system and less effort to replace such consumption have severely affected energy use.

### **Statement of the Problem**

The majority of the studies conducted concerning renewable energy systems for rural areas are focused on environment, technical and economic aspects. Renewable energy offers a large portfolio of different sources and technologies. Those countries that have deployed renewable so far were driven by climate change mitigation, but also by energy diversification, and the reduction of fossil fuel imports. Other drivers have been economic growth aspects such as job creation and mitigation

of local pollution (IEA, 2012). Though public acceptance has been recognized as an important issue shaping the widespread implementation of renewable energy technologies and the achievement of energy policy targets (Wright, 2008), very few studies have focused on the public acceptance and have narrow turn on national level (UNEP, 2007). In case of Nepal too there has not been any research which has been done solely to understand local community perceptions of renewable energy technology.

Therefore it has been necessary to find out how does community perceive the effects of renewable energy technology? In addition, the factors that influence the community perception still need to be prioritized. So it been high time, more research is needed in order to gather a clearer and more sensitive understanding of public attitudes and the ways they are formed and developed. As Kahn (2001) observed, there is a need to study renewable energy siting from different scientific disciplines and theoretical perspectives, in order to develop a more structured understanding about what characterizes renewable energy siting conflicts (p. 28). Therefore, public belief of renewable energy in Nepal, particularly focusing on Improved Cook Stove (ICS) in terms of perception of community on application and effects is the major concern of my study.

### **Purpose of the Study**

The main purpose of this study is to explore the community perception on application and effects of Improved Cook Stove in Mangaltar VDC and Panauti Municipality of Kavrepalanchok District. Particularly my research intends to identify the contribution of Improved Cook Stove in children education, study its effect on environment and health and articulate and demonstrate its effectiveness for an ICS user.

### **Research Questions**

This research seeks to answer the following research questions:

- i. What are the effects of Improved Cook Stove on environment and health aspects?
- ii. What contribution is made by Improved Cook Stove in children education?
- iii. How do the user articulate and demonstrate the effectiveness of Improved Cook Stove?

### **Importance of the Study**

The world population is increasing at rocketing speed. This increases the demand of energy accordingly. In the present context, this will certainly concentrate the pressure on fossil fuel to fulfill the increasing demand of energy. But such use of energy based on fossil fuel not only decreases their stock (that can cause abrupt energy crisis) but the fossil fuel is also the causative agent for major environmental pollution. So this scenario creates the need for the optimum use of alternative energy so that we can abide by the principal of sustainable use of natural resource management.

This study will help to understand the perception of community on Renewable Energy Technology: Improved Cook Stove in context of rural Nepal. This study will help to understand if there is excess use of resources and can also help to identify alternative energy sources. With the help of this study we can also make planning for sustainable use of resources. Alternative energy is beneficial because, most of the sources of alternative energy are renewable in nature and its use limits the pollution. Sources of alternative energy are an appropriate solution for present threat of energy crisis.

### **Organization of the Study**

The study is divided into eight chapters. Chapter I covers the introduction, statement of the problem, rationale of the study, purpose of the study, limitations of the study and organization of the study. Chapter II discusses the review of literature. Chapter III presents methodology applied in the study. The methodology includes the research method, study area, instrumentation, data source, sample size, data collection procedure, quality standard and methods of data analysis. Chapter IV presents the study results and discussion. Finally, Chapter V present summary, findings, discussion, conclusion and recommendation.

### **Chapter Summary**

This chapter presents information starting from basic concept of energy, highlighting research statement and finally setting the scenario. To give direction to the study, research questions have been supported by rationale or significance of the study. In addition limitation has helped to bound the working areas of the study. Furthermore organization has given overall scenario of whole thesis work.

## CHAPTER II

### LITERATURE REVIEW

#### **Chapter Overview**

This chapter describes the major literatures that were reviewed for research. It has been divided into three parts, thematic, theoretical and past study review. Thematic review presents the introduction of renewable energy, its sources and its technology. Theoretical review comprises of sustainable development theory and sustainable natural resource conservation theory. Study done in past on impacts of ICS in other districts like Baitadi, Dadeldhura, Kathmandu and Palpa are reviewed in this chapter.

#### **Background**

Thematic reviews of literature are organized around a topic or issue and allow us to look at the specific issues more closely and make the relation between all these respected concerns. On basis of these themes research problems and questions can be justified.

#### **Renewable Energy**

Renewable energy is the energy that is derived from sources that do not harm the environment or deplete the Earth's resources. Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides and geothermal heat, which are renewable (naturally replenished). About 16% of global consumption comes from renewable, with 10% coming from traditional biomass, which is mainly used for heating, and 3.4% from hydroelectricity (REN, 2011).



## Renewable Energy Technology (RETs)

Renewable energy technologies are energy-providing technologies that utilize energy sources in ways that do not deplete the Earth's natural resources and are environmentally benign. These sources are sustainable in that they can be managed to ensure they can be used indefinitely without degrading the environment (Renewable Energy Association, 2009). By exploiting these energy sources, RETs have great potential to meet the energy needs of rural societies in a sustainable way, albeit most likely in tandem with conventional systems. RETs can be separated into two categories: those used to provide energy for domestic use (predominantly cooking and heating) and those used to supply electricity. Table 1 lists renewable energy sources, as defined by the United Kingdom Renewable Energy Association.

Table 1

Renewable energy sources and corresponding RETs

Energy Sources	RETs	
	Energy for domestic use	Electricity
<i>Elemental renewable</i>		
Solar	Solar pump, solar cooker	Solar PV
Water (including wave/tidal)		Micro-and pico-hydroelectric generating plant
Wind	Wind powered pump	Wind turbine generator
Geothermal		Geothermal generating plant
<i>Biological renewable</i>		
Energy crops		Biomass generating plant
Standard crop (and by-product)		Biomass generating plant
Forestry and forestry by-products	Improved Cook Stove	Biomass generating plant
Animal by-products	Biogas digester, Improved Cook Stoves	Biogas digester

(Source: Renewable Energy Association, 2009)

Common RETs options for providing energy in rural areas utilize wind, solar, small-scale hydropower and biomass resources.

## **Improved Cook Stove**

Improved Cook Stove (ICS) is one of the most simple, inexpensive and widely used technologies designed to improve combustion efficiency of biomass and reduce exposure to indoor air pollution (AEPC, 2008). This type of stove has become one part of income generation activity and women groups in particular have been active in improved stove production and marketing. ICS can do much to reduce the pollution levels in the kitchen, as well as to maintain cleaner kitchen environment. They also reduce women's work burden and give them a sense of modernity and increase their sense of wellbeing (AEPC, 2008).

## **History of ICS in Nepal**

ICS was introduced in Nepal in 1950s and continues to be relevant in the present context. At that time "Hydarabad and Magan stoves" (an Indian model of ICS) were implemented as part of Village Development Services of the " Tribhuvan Village Development Program" (Forestry Nepal, 2010). That program was ended in the early 1960s. After that a number of organizations such as UNICEF, Peace Corps etc. integrated ICS dissemination in their other development activities during 1970s (CRT, 2000).

In 1980s National Planning Commission included ICS in a Plan document in attempt to address the pressing fuel wood problem. In 1981 Community Forest Development Project (CFDP) developed prefabricated ceramic ICS. In 1982, prefabricated ceramic stoves were tested, and after some modification, RECAST developed Ceramics Insert Stoves.

During 1985 Small Farmer Development Project (SFDP) of Agriculture Development Bank (ADB/N) distributed Ceramic Insert Stoves. Other major organizations and projects which took up further ICS dissemination efforts include

United Mission to Nepal (UMN), Terai Community Forestry Development Project (TCFDP), Nepal-Australian Forestry Project, Resource Conservation and Utilization Project (RCUP), CARE/Nepal etc.

RECAST developed a new model of stove known as "Improved Tamang Stove". They tried to make the stove with cheap readily available local materials. Since early 1990s, new initiatives from various NGOs, INGOs and GOs, for ICS dissemination have been underway.

Most of the organizations working on ICS programs concentrate on Mid hill and Terai regions, and they are mainly working on Mud Stoves. Very few of them are involved in high altitude places, and very few work on metal stoves (CRT, 2000).

According to AEPC, which is a government organization, there is no subsidy in ICS programs but they only give training on building stoves using local resources and materials (CRT, 2000). AEPC, together with other government, non government and private organizations, is involved in developing and promoting different types of Improved Cook Stove in Nepal.

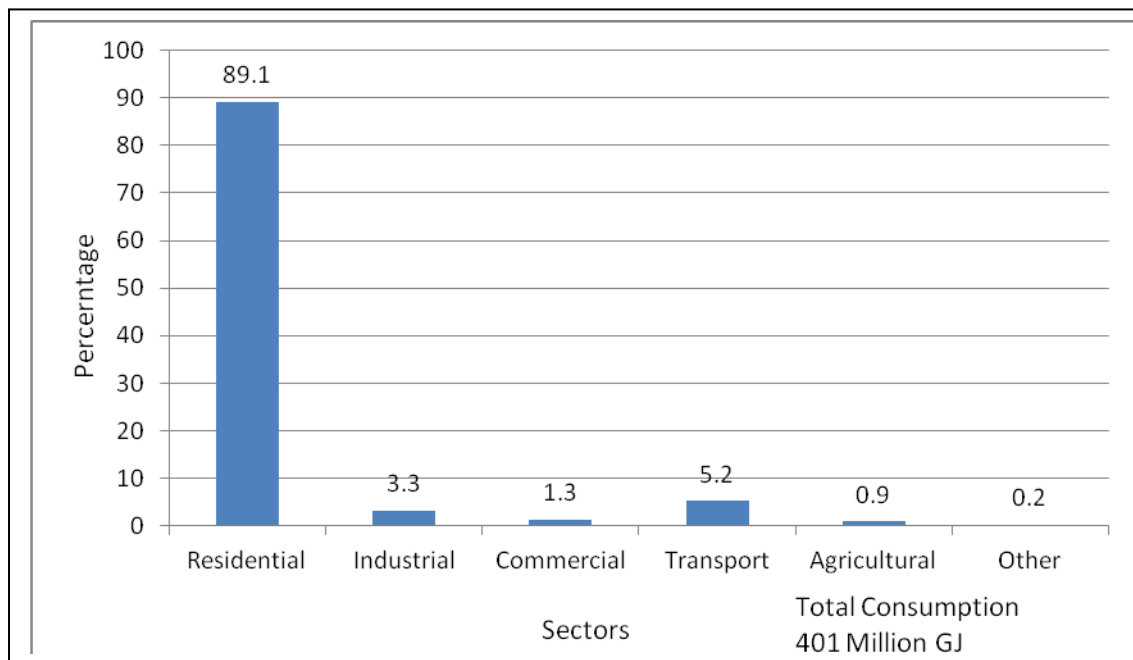
### **Energy Scenario of Nepal**

Although the human beings have taken huge step towards the world of information and technology, Nepal is still lagging behind in terms of technology and its uses. The theoretically estimated sustainable annual yield of fuel wood in Nepal is 25.8 million tonnes per ha of forest. However, only 42% or 10.8 million tonnes, of the theoretically sustainable supply is accessible (Rijal, 1998). Fuel wood supplies almost 80% of total energy demand of Nepal (Nakarmi, 2002). The hydro electricity capacity of Nepal is 0.584 million kilowatts (RECIPES, 2005) but electricity supplies only 1% of total energy consumption. Only about 542 MW of 83 GW potential has been

developed. Nepal has considerable scope for exploiting its potential in hydropower, with an estimated 42,000 MW of feasible capacity (RECIPES, 2005)

In Nepal there has been a rapid increase in dissemination of Solar Home System (SHS) and Solar Tuki as a result of the different interventions undertaken by Energy Sector Assistance Programme (ESAP).

The petroleum products consumed in Nepal are imported in refined form for direct consumption. Import is the only method to meet the demand for petroleum products. There is a considerable increase in the supply of Liquidified Petroleum gas (LPG) because of recent trend to replace the use of kerosene, electricity and fuel wood in urban and semi urban areas. Similarly, coal consumption is also met through imports, which amounts to about 250,000 short tons per year (Nakarmi, 2002). Coal consumption in Nepal is about 0.380 millions short tonnes/year (RECIPES, 2005).



*Figure 1.* Sectoral Energy Consumption in Nepal (2008/09) (WECS, 2010).

The overall energy consumption of the country is largely dominated by the use of traditional non-commercial forms of energy such as firewood, agricultural residue and animal waste (District Energy Situation Report, 2013) . Kavrepalanchok district is

not an exception in this regard. Residential sector occupies a major share in the overall energy consumption in Nepal. It is also true in the case of the district. The principal five sectors considered for the consumption profile are: residential, agricultural, industrial, commercial and transport. They represent the major human activities that consume traditional and commercial energy in the district. But the data on energy consumption for agricultural and transport sector in Kavrepalanchok district could not be obtained. Table below indicates the total sectoral energy consumption for the year 2010/11 in the district.

Table 2

Total Sectoral Energy Consumption in 2010/11 in Kavrepalanchok

<b>Sectoral Energy Consumption</b>	<b>Total (GJ)</b>
Residential Sector	38,80,386
Commercial Sector	34,902.7
Industrial Sector	39,108

(Source: District Energy Situation Report, 2013)

The share of each fuel type in total energy consumption of Kavrepalanchok district in residential sector for the year 2010/11 is shown in Annex C.

### **Potential of Renewable Energy Technology in Nepal**

Energy is directly related to increasing production of the country. However, sustainable energy development requires efficient use of energy, which also can increase production. Since Nepal is rich in supply of resources, such as water, sun, biomass and wind, there is a great potential for the development of RETs. Appropriate mobilization of these locally available resources provide energy services even for the poor sections of the country.

## **Biomass Potential**

Nepal, being an agriculture country, has a plentiful supply of agricultural residue and animal waste. Nepal is rich in forest resources as well. Therefore, the country has a potential for biomass energy.

Biogas energy is considered to be one of the most promising and sustainable sources of renewable energy in the context of Nepal. It is estimated that a total of 28.1 million tons of dung is available per day for biogas production. The potential number of biogas plants is estimated to be 1.5 million, of which 62% are in Terai, 37% are in hilly region and 1% in mountain region (MoEn, 2003).

The use of rice husk has been dramatically used for industrial heating and process heating purposes. Briquetting technology is mostly used in Terai region of Nepal as plenty of rice husk useful for briquetting is available in this region.

Improved Cook Stove (ICS) has the potential to reduce greenhouse gas, indoor air pollution and consumption of firewood. Since 1980, when ICS began in earnest, Government of Nepal has played an important role in promoting and disseminating. A number of NGOs and INGOs have included ICS as integral part of their overall development objectives and programmes. So far 5,00,000 ICS of various types have been promoted and distributed by Nepal Government, NGOs and private sector agencies (AEPC, 2013).

## **Micro-hydro Potential**

Nepal is rich in water resources. There are 6000 large and small rivers in the country. The potential to generate power from micro-hydro is estimated to be 83000 MW. Out of this, 42000 MW generation of power is feasible.

### **Wind Energy Potential**

There is a potential of wind energy in many hilly and mountainous regions of Nepal. Wind power potential of 200 MW in 12 km corridor from Kagbeni to Chusang has been estimated. Annually about 500 GWh energy from the wind can be generated in this region (Shrestha, nd). Similarly, Mustang and Khumbu region in eastern mountain is also identified as a potential area for large scale exploration of wind energy. Besides these area, many other hilly parts of the country such as Karnali River along with the East-West High way, Batase Danda of Palpa, Rampur of Chitwan, Tarahara of Sunsari, Arun valley, etc have small scale wind energy potential.

### **Solar Energy Potential**

Nepal has 300 sunny days per annum and thus it is very rich in solar power potential. The average solar insolation is 4.5 kWh/m<sup>2</sup>/day. If we use just 0.01 % of the total area of Nepal, we can generate solar electricity of 8 GWh/day that is 2920 GWh/year which is more than the energy generated by NEA in the year 2003 which amount 2261 GWh/ year (Shrestha M., n.d.).

### **Subsidy Provision on RET**

Developed nations have already taken gigantic steps toward technological innovation whereas Nepal, being a developing nation, is lagging behind. More than 85% of the total population still lives in rural areas (Nakarmi, 2002). In these circumstances there is need of subsidy on RETs in Nepal if RETs is to be disseminated in every corners of the country.

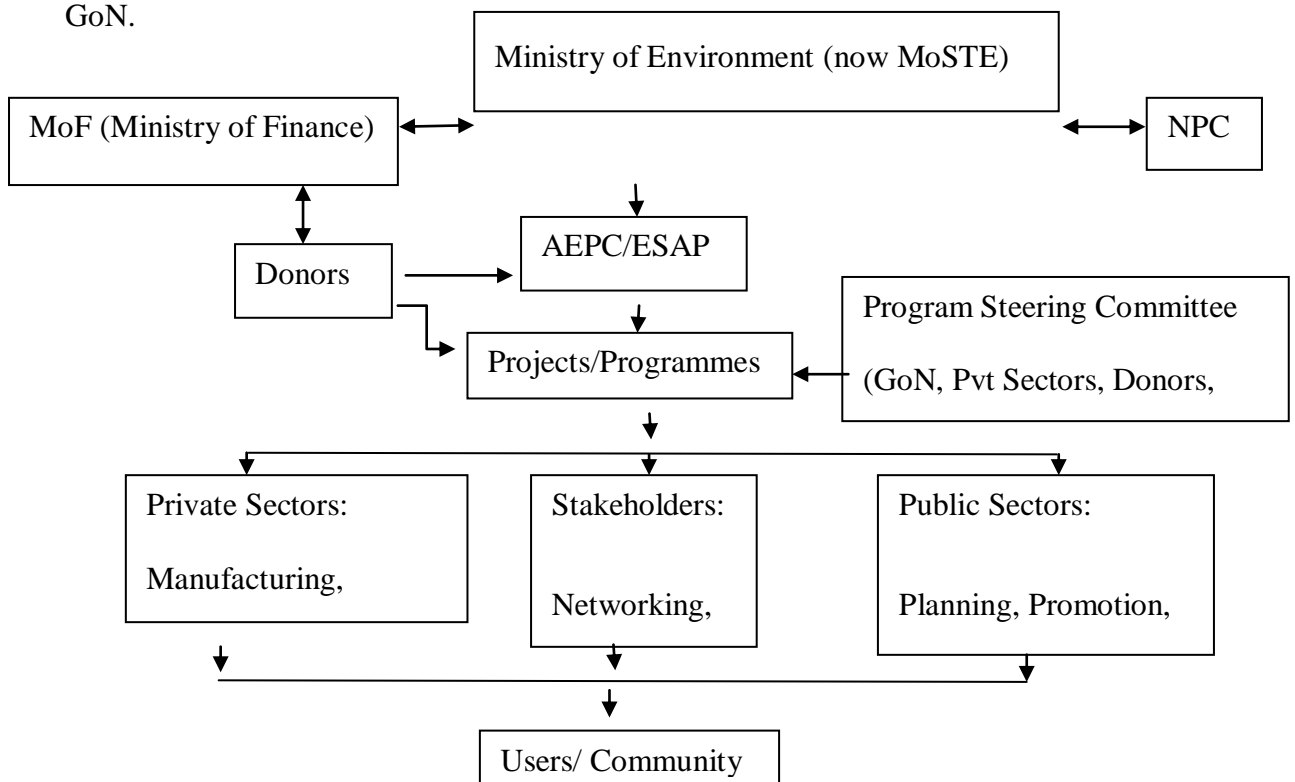
### **Subsidy Provision for ICS**

According to AEPC, there are no subsidies in ICS programs till now. There used to be subsidy programs on ICS a few years ago, but now they only give training on building stoves using local resources and materials. However in terms of Metallic

ICS, Rs 4000 as subsidy is given for three pot hole stove and Rs. 2700 for two pot hole.

### **Overview of Technical Support and Networking of RE Institutions for RE Institutions for Renewable Energy Service Deployment**

The diagram below shows networking of RE in Nepal for development, promotion and deployment of RE and technical support and service provided by the GoN.



*Figure 2. Networking of Institutions of RE Deployment (Adhikari, 2011)*

Ministry of Finance (MoF) mainly focuses on maintaining both micro and macro economic stability in the country. The key role of the Ministry lies with the more rationale allocation of resources, better management of public expenditure, enhanced mobilization of both internal and external resources, greater performance in the public investments and strengthening of public enterprises productive capacity, open and simple foreign exchange policies and regulation, and prudent fiscal and monetary policies (MoF,



2011). Here, in relation to renewable energy, it is directly concerned with development of renewable energy technologies in Nepal.

Ministry of Environment (now Ministry of Science, Technology and Environment) is responsible for formulation of plans and policies that concerns with renewable energy.

National Planning Commission (NPC) explores and allocates resources for economic development and works as a central agency for implementing, monitoring and evaluation of development plans, policies and programmes (NPC, 2011). Although the functional scope of NPC is much wider, NPC has given proper attention to the policy aspects of renewable energy.

Alternative Energy Promotion Center was established in 1996 with the objective of developing and promoting renewable/ alternative energy technologies in Nepal. AEPC is the apex government body under Ministry of Environment. It functions independently, and has a nine member board with representatives from the government sector, industrial sectors and non-governmental organizations. AEPC is responsible for formulation of policy in renewable energy, subsidy delivery coordination, promotion of the technology, research and development on renewable energy, quality standardization capacity building of private sector, human resource development, etc. in Nepal.

A number of District Development Committees (DDCs) and Village Development Committees (VDCs) are involved in promotion of renewable energy technologies. In addition, District Energy and Environment Sections (DEES) have been established in 40 districts and in 32 districts the District Development Committee (DDC). Both of these section/units are involved in promoting renewable energy in the districts (MoEn, 2011).

AEPC/ESAP has established 8 Regional Renewable Energy Service Centers (RRESC) in different regions of the country. These centers are the national level NGOs working as partner organizations of AEPC/ESAP. They work in close coordination with local organizations to promote RETs in their working districts (Adhikari, 2011). The above diagram gives the overall view of delivery service mechanism of GoN with regards to renewable energy technologies in Nepal.

### **Effects of Renewable Energy Technology**

**Environmental effects of renewable energy technology.** To combat global warming and other problems associated with fossil fuels, switching towards renewable energy sources like sunlight, wind, and biomass is necessary. A study by the Union of Concerned Scientists and Americas' Energy Choices found that even when certain strict environmental standards are used for evaluating renewable energy projects, these energy sources can provide more than half of the United State energy supply by the year 2030 (Brower, 1992).

The use of biomass energy has many environmental benefits if the resource are produced and used in a sustainable way. By the use of Improved Cook Stove, fuel wood consumption has been reduced by about half as compared to that of Traditional Cook Stove (TCS). Also indoor air pollution has been reduced by 30% to 90%. Study has shown that Greenhouse Gas Emissions have been reduced by about 2.5 ton CO<sub>2</sub> per year per stove (Alternative Energy Promotion Center, 2008).

**Health effects of renewable energy technology.** Greater access to energy for domestic and electricity using RETs can have significant impacts on livelihoods in rural areas. Cleaner use of traditional fuels can significantly improve health by reducing acute respiratory infection and conjunctivitis, commonly caused by indoor air pollution. Wider health benefits can occur too; cooking with more efficient

technologies can make dietary choice and boiling of water more affordable or more likely. Women and children in particular have more time for education, leisure and economic activity (Murphy, 2001).

According to AEPC, use of ICS has diminished fewer respiratory diseases particularly lower respiratory infection such as pneumonia among children and Chronic Obstructive Pulmonary Disease (COPD) among women. In addition to this few eye problems as well as other health problems such as headaches have reduced among the women and children as the use of ICS has reduced fire hazard in the kitchen.

### **Contribution of Renewable Energy Technology on Children Education**

Renewable energy can contribute to education, by providing electricity to schools. Renewable energy for cooking and heating purpose can reduce the time that children spend out of school collecting fuel.

**Education system in Nepal.** The education system in Nepal covers both formal and informal education. Formal education is divided into two parts: school education and higher education. The study will be based on both formal and informal education system. School education consists of ten years of schooling including five years of primary schooling, three years of lower secondary and two years of secondary schooling.

After completion of schooling, the student is eligible to attend the School Leaving Certificate (SLC) examination. The students get a choice to join colleges at Proficiency Certificate Level (PCL) or higher secondary education which consists of two years of training and then after, one can be eligible to join bachelor level which consists of three to four years of training depending on the policy of university. The bachelor level is followed by Masters Degree. After Masters Degree one can continue

for further higher level of studies like Master of Philosophy (M.Phil.) and Doctorate of Philosophy (PhD) which are more research oriented studies.

Although the Government of Nepal (GoN) has taken the position that every child has the right to perceive quality basic education, only primary education is free but not compulsory. In the Interim Constitution 2007, education has been recognized as a fundamental right.

**Education and development.** Education prepares independent people in society and enables them to carry out a number of responsibilities in a professional way. Education also develops human being to become efficient and economic and creates civic awareness among the people in a society for obtaining mutual benefits. Finally, education helps to develop overall personality of the individual to make their life easier and enhance their capacities and could be very helpful for developing the family, the society and the nation. Without education, the transformation of society and nation to compete the rapidly growing globe might not be possible.

**Education and empowerment.** Education is the first condition for empowerment. The Human Empowerment Index (HEI) designed by UNDP has been constructed by bringing together the available social, economic and political indicators into a composite index of empowerment (UNDP, 2004). The empowerment process cannot become sustainable or even possible without quality education. Access to basic education is a must for the initiation of empowerment of people in a country. It is also recognized that investment in education would have benefits like reduction in poverty, freedom of choice, improvement in maternal and child mortality, reduction in fertility rates in the longer term, creation of employment and ultimately transformation of the society (UNDP, 2005).

## **Indoor Air Pollution (IAP) in Developing Countries**

Most people think of air pollution as occurring in outdoors-urban locations in industrial countries where fossil fuels are the principal source of emissions. It is generally considered to be a problem either in association with tobacco smoking or with occupational settings dominated by men.

The smoke from burning biomass fuels turns kitchen in the world's poorest countries into death traps. Indoor air pollution from the burning of solid fuels kills over 1.6 million people, predominantly women and children each year which is more than three people per minute (Parajuli, 2005). It is a death toll almost as great as that caused by unsafe water and sanitation, and greater than that caused by malaria. Smoke in home is one of the world's leading child killers, claiming nearly one million children's lives each year.

Indoor air pollution is not an indiscriminate killer. It is the poor who rely on poor grades of fuel and have least access to cleaner technologies. Indoor air pollution affects women and small children far more than any other sector of the society as women spend most of their time by the fires exposed to smoke often with young children nearby.

According to WHO report 2002, causes of death in the world's poorest countries is from exposure to indoor air pollution and the victims are women and children. Children aged below five account for 56% of total deaths from indoor air pollution (Parajuli, 2005). The main cause of indoor air pollution is the acute lower respiratory infection.

### **Health Effects of Indoor Air pollution**

There is a substantial body of evidence that exposure to smoke in the home is a huge health hazard. As with most medical knowledge there are difficulties in

drawing exact conclusions as to what levels of exposure to smoke will cause what levels of diseases, as there are so many other factors which contribute to ill health, however, the evidence is clear that smoke in the home is a major risk.

### **Theoretical Review**

In this section, different theories that support the study are reviewed.

#### **Sustainable Development Theory**

Sustainable development means building our communities so that we can all live comfortably without consuming all of the resources. The concept of sustainable development emerged from anxieties that accompanied the successful rise in living standards enjoyed in developed countries during the second half of the 20<sup>th</sup> century. The framework of sustainable development defines the parameters for an economic development approach in accordance with social and environmental needs (UNEP, 2007). The basics of the framework were set with the publication of the Report of the World Commission on Environment and Development in 1987, known as the Brundtland Report. Here, sustainable development was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WECD, 1987). Energy is the basic ingredient for development. Sustainable energy is the energy which is local, environment friendly, replenishable and that meets different types of demand.

Globally, buildings are responsible for approximately 40% of the total world annual energy consumption. Most of this energy is for the provision of lighting, heating, cooling, and air conditioning. Increasing awareness of the environmental impact of CO<sub>2</sub> and NO<sub>x</sub> emission and CFCs triggered a renewed interest in environmentally friendly cooling and heating technologies. (Omer, 2005)

There is strong evidence that the average temperature of the earth's surface is rising. This is a result of the increased concentration of carbon dioxide and other GHGs in the atmosphere as released by burning fossil fuels. This global warming will lead to changes in earth's climate which will in turn have major impact on human life and the built environment (Omer, 2005). Therefore effort has to be made to reduce fossil energy use and to promote green energies in a sustainable way. The adoption of green or sustainable approaches to run a society is an important strategy in finding a solution to the energy problem.

### **Sustainable Natural Resource Conservation Theory**

Natural resource management deals with managing the way in which people and natural landscape act together. It deals together with land use planning, water management, biodiversity conservation and sustainability of agriculture, mining, tourism, fisheries and forestry.

Sustainable utilization of natural resources for accelerated economic growth is one of the major challenges that is being faced by government of Nepal. To achieve fast paced economic development, Nepal has no alternative but to harness the natural resources. When the country attempts to expedite its economic development by harnessing natural resources, overutilization and degradation of natural resources compromising the sustainability of economic development are high. Therefore, it is crucial to follow a sound environmental and natural resource policy decision-making process while utilizing the nation's natural resources for economic development (Poudel, 2010).

In 1953, Nepalese government formed a Land Reform Commission and its First Five-Year Plan was launched in 1956. Since that time Nepal has successfully completed 10 five-year plans and is currently into the Three-year Interim Plan.

Through the development in agriculture, forestry, water resources, population control, trade, transportation, industries and other issues, the overall development of nation was emphasized by this plan. The development of long term plans such as Master Plan for the Forest Sector (MPFS) (1989-2010), the Agriculture Perspective Plan (1997-2017), the Nepal Water Plan (2002-2027), the Renewable Energy Perspective Plan of Nepal (2000-2020), the Perspective Energy Plan (1991-2017) and the Tiger Conservation Action Plan (2008-2012), clearly indicate Nepal's emphasis on environmental and natural resources for the nation's economic development (Poudel, 2010). The Nepalese government has developed numerous environmental and natural resources policies, guidelines, acts and regulations after Nepal began planned development. Recognizing the vast natural resources in Nepal, theoretical framework based on sustainable development and management of eight "Ja"- Nepali letter "Ja" has been proposed. They are Jal (water), Jamin (land), Jungle (forest), Jadibuti (medical and aromatic plants), Janshakti (humanpower), Janawar (animals), Jarajuri (plants) and Jalabayu (climate).

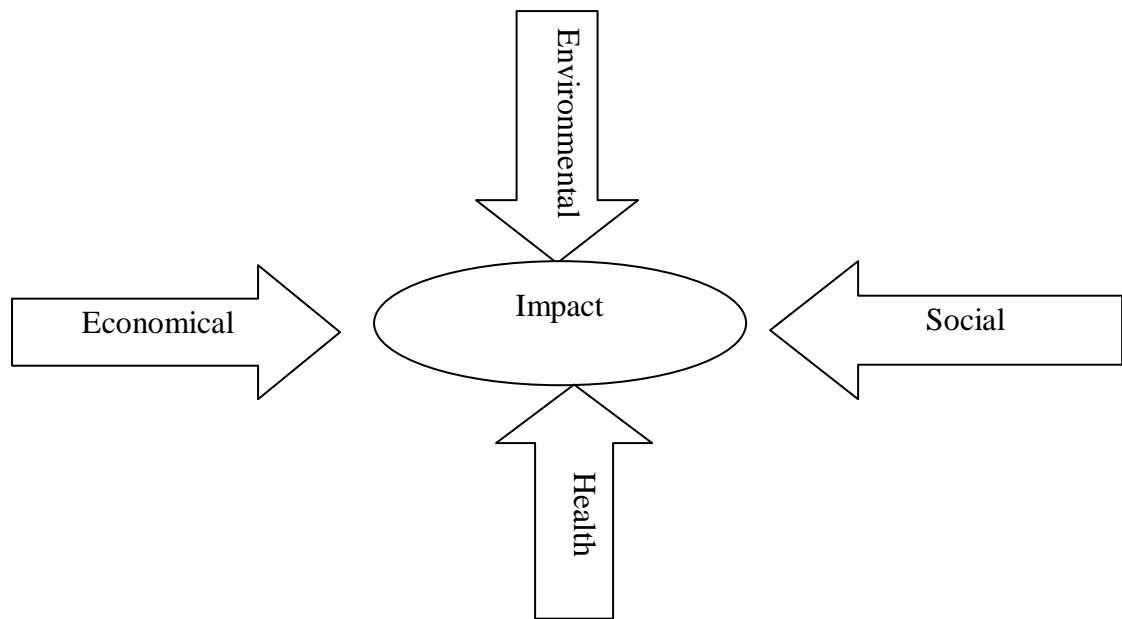
### **Past Study Review**

In this section different related and relevant research papers, journal articles and studies are reviewed.

### **Participatory Performance/ Impact Monitoring Report on ICS Program**

There are various impacts of ICS like environmental, social, health and economical impact. Study done by Central for Rural technology (CRT) in Baitadi and Dadeldhura districts found that most of the household use ICS in the following districts.





*Figure 3.* The impact of ICS in different aspects.

**Health aspect.** Health is one of the aspects on which ICS has direct impact. Indoor air pollution is one of the prominent health issues in Baitadi and Dadeldhura districts. In the group discussion of users, promoters and office staffs it was found that ICS has reduced all the disease caused by the smoke such as eye problems, cough, asthma, ARI (Acute Respiratory Infection) by removing smoke from the kitchen. 90% of ICS users got smoke free kitchen environment after the installation of ICS leading to reduced health problems due to smoke (CRT, 2002).

**Social aspect.** ICS is also a factor that makes an effect on social aspect. Different social aspects such as gender role balance, decision-making structure and drudgery reduction of a household are considered on effect of ICS. Perception from group discussion found that there has not been significant improved gender role balance after ICS installation (CRT, 2002). However, men have also supported female in cooking during specific time. The study shows that women have played significant role on decision making for choice of ICS. In addition to this drudgery of female members is reduced.

**Economical aspect.** In economic status of community also, ICS makes a positive impact. Various issues such as cost of ICS, fuel saving, time saving and opportunity cost are considered in the study. ICS has reduced the expense of washing powder and soap for clothes wash by removing the smoke out of kitchen. The study found that ICS has reduced the expense of treatment of the diseases caused due to smoke by removing it out from the kitchen. In addition to this, it has economical advantage for the promoter by being an additional means of income generation to them.

**Environmental aspect.** ICS has effects on different aspects of the environment mainly on air and forest. As compared to TCS, majority of ICS have consumed less fuelwood and have helped to conserve forest. For fuelwood, community depends on community forest, own farm and local market. The study also shows that 90% of ICS installed by the promoter has removed the smoke completely out of kitchen (CRT, 2002). Due to problems in chimney and chimney outlet some of the ICS in the study areas have not removed the smoke completely out of the kitchen.

The ICS programs in Baitadi and Dadeldhura districts have made positive impact on social, economical, environmental and health aspects. 72 % of ICS user in Baitadi and 67% in Dadledhura districts have saved 29% of fuelwood which reveals that majority of users have saved significant amount of fuelwood (CRT, 2002). Also ICS has improved the indoor air environment by removing the smoke out from the kitchen and has decreased health expenditure by reducing illness in the community. From the study it can be said that female also almost equally participated in decision making for ICS installation.

### **Impact Study of ICS in Ghhaimale VDC of Kathmandu**

The study on promotion and impact of Improved Cook Stove done in Ghhaimale VDC of Kathmandu shows the positive thought about ICS among the users and non users as well. The study found that most of the people in study area were not aware about ICS though they had heard about it. In addition to this it was difficult to access the ICS in local level and high cost was the problem to use ICS. The community accepted that ICS has different advantages such as time saving, easy to cook, yielding less smoke, less consumption of fuel wood and so on but most of them use TCS as they were not able to buy ICS. After the installation of ICS, the saved time was utilized for educational purpose and income generating activities which helped to improve the social condition and literacy rate of the people (KC, 2005). The study also shows the improvement in kitchen environment and health condition of the community as it emits less smoke. With the use of ICS deforestation was considerably reduced which has solved the fuelwood problem in the community.

### **A Comparative Study on Indoor Air Pollution of ICS vs. TCS**

Study on indoor air pollution between ICS and TCS was done in Khasauali and Bhairabsthan VDC of Palpa district. In the study to assess the indoor air quality, the level of emission of CO was measured through CO monitor and PM level was identified through PM pump set. Questionnaire survey, interview with the key person and focus group discussion were done to assess the impact on women's and children's health. The difference in emission level of ICS with that of TCS was compared in the study. The health status of women and children was found to be varied with different type of cook stove used by community. The study shows that indoor air quality of the household in the study area is not satisfactory and is below the permissible level of emission according to WHO standard (Parajuli, 2005). The emission level of both

household with ICS and TCS was found below the WHO permissible value for protecting the public health of study area.

### **The Cleaner Energy Options for Indoor Air Pollution Control in Rural India**

There is indoor air pollution problem in rural India. The problem of indoor pollution in rural India particularly of solid fuels is a major source of health risk. The stoves of low efficiency like traditional stoves, open fire three-stone stoves and others emit smoke containing harmful pollutants. For those exposed to, a serious health consequence particularly among women and children has been seen. Health impact surveys show increased incidence of chronic bronchitis in women and acute respiratory infections in children in rural India.

There was strong participation of community. The energy need of the project villages was assessed and village micro plans were prepared through participatory rural appraisal. Also training and awareness raising programs regarding the project were conducted. In the project 18 biogas plants were constructed with capacity of 2 m<sup>3</sup>/day (Boojh, n.d.). The benefits of the project are shown in following table:

Table 3

Health and economic benefits of biogas plant project

Health benefits		Economic benefits	
Approx. spending on medicines	Rs. 2400/yr	Cost of conventional fuels being used	Rs. 2.50/kg
Human days loss due to sickness	84 days/yr	Total cost incurred on cooking energy per household/ yr	Rs. 3125
Value Rs 100/ a day	Rs. 8400/yr	5kg@Rs 2.50*250 days	
Total health benefits	Rs. 10800/yr	Value of digested slurry/yr	75 tons
Total economic benefits	Rs. 17725/yr	Value of N, P, K at 20% moisture content	1.4, 0.8, 1.6%
		Cost of chemical fertilizers to be replaced by slurry	Rs. 3800/yr

(Source: Boojh, n.d.)

### **Indoor Air Pollution: The Case of Pakistan**

In Pakistan various studies and surveys reveal that acute respiratory infections, diarrhoea, malnutrition and vaccine preventable disease are the main factors for high infant and child mortality. ARI accounts for 160,000 deaths per year. Mortality due to ARI is surfacing as the number one killer of under 5 year old children in Pakistan (Sindhu, n.d.).

There is high child and adult mortality in Pakistan. Efforts are adopted to control IAP in Pakistan. Policies and practices such as adoption of Improved Cook Stove, Improved House Designs, Cleaner Fuel Options especially LPG and Solar/wind devices and advocacy and awareness program are some of the efforts to control IAP (Sindhu, n.d.).

### **Education for All**

Every missed opportunity for an education is a loss for the child, since education speeds human empowerment and transforms society (UNICEF, 2010). Child friendly school is the strategy of UNICEF to advance the quality education, which aims not only to educate children but also to ensure that they are healthy, well nourished and have access to safe water, improved sanitation and hygiene education. By 2010, while primary education was within reach for many countries, this was not the case for many others and not for all people in countries with otherwise impressive national achievements. Among 67 million children who are out of primary education 43% are in sub-Saharan Africa while 27% are in South and West Asia (UNICEF, 2010). According to UNICEF, only 53 out of 171 countries claim to have same number of girls and boys in both primary and secondary schools. In 2010, UNICEF continued helping countries improve educational quality as well as increase the

number of children who attend and finish schools. In addition to this, it emphasized on removing the inequities that undercut options for an education.

UNICEF has helped countries in all regions establish the national frameworks they need to make education better and more inclusive. It is active on all fronts like sound teaching and learning materials, well designed curricula, school facilities that are safe and clean, and mechanisms to protect children from harm. Quality education contributes to the MDG goal of universal primary education as it encourages pupils to go to school and stay there. UNICEF helped 7500 education practitioners acquire new skills in school planning and teaching in Indonesia. Few of the students dropped out and more of them made transition from primary to secondary education. UNICEF also provided assistance for the training of 1300 teachers and setting up special programme to aid about 10400 students in making the transition in Argentina.

In 2010, UNICEF and UNESCO launched a global initiative in 20 countries to address the challenge of out of school children. Globally, girls, in numbers disproportionate to boys, are denied their right to education because of their gender. In 2010, international partners, child rights activists, policymakers and scholars met in Dakar and agreed to do more to establish high quality school curricula that empower girls. In Chad, UNICEF targeted efforts in four departments with low enrollments rates among girls helped bring nearly 51,000 students to class, almost half of them were girls. In Bosnia and Herzegovina where 200,000 children are disadvantaged by poverty and exclusion, UNICEF provided assistance to establish an early childhood development systems that builds on existing services but also strengthens referral mechanisms and extends outreach. In Sri Lanka, UNICEF worked closely with Ministry of Education and ensured 80,000 internally disabled children continue their education (UNICEF, 2010).

## **Country Education Programme in Nepal**

UNICEF education programme in Nepal works to improve access to quality learning opportunities for all children, and enable girls and disadvantaged children to complete a basic education cycle and graduate to lower secondary level.

**Early childhood development.** Currently there are more than 16,500 Early Childhood Development (ECD) centers in Nepal, mainly in urban areas with a gross enrollment rate of 60.2% for 3-5 years old (UNICEF, 2010). Research by UNICEF shows that ECD plays an important role in successful transition of children to school with lower drop out.

**Formal primary education.** In Nepal there are approximately 29,220 primary schools teaching 4.3 million children. Around 89% of children aged 6-10 are enrolled in primary school (UNICEF, 2010). Mostly girls and children from disadvantaged households in rural areas are out of school children. Schools lack child and girl friendly facilities and child centered teaching learning environments leading to drop out especially in Grade 1.

**Non Formal primary education.** There are some 250,000 primary aged children out of school majority being girls and children from disadvantaged household in rural areas. 40% of children aged 6-14 years missing the opportunity to enroll in school or drop out receive quality education through non formal education programmes in UNICEF supported districts (UNICEF, 2010). Children graduating from this non formal education are mainstreamed into formal education system.

**Peace education and emergency education.** While many schools were caught in conflict, the students and teachers were not allowed to attend school due to strike and intimidation. UNICEF support Curriculum Development Center and the

Ministry of Education and Sports to develop peace education materials, train teachers and pilot the curricula in selected working districts.

### Conceptual Framework

Conceptual framework in research is used to outline possible courses of action or to present a preferred approach to an idea or thought. This implies that conceptual framework framed to answer my research question provided me structure and plan for appropriate variables while eventually helped me to collect responses from the respondents thereby making it simpler and systematic throughout my study. The conceptual framework of the research is shown as follows:

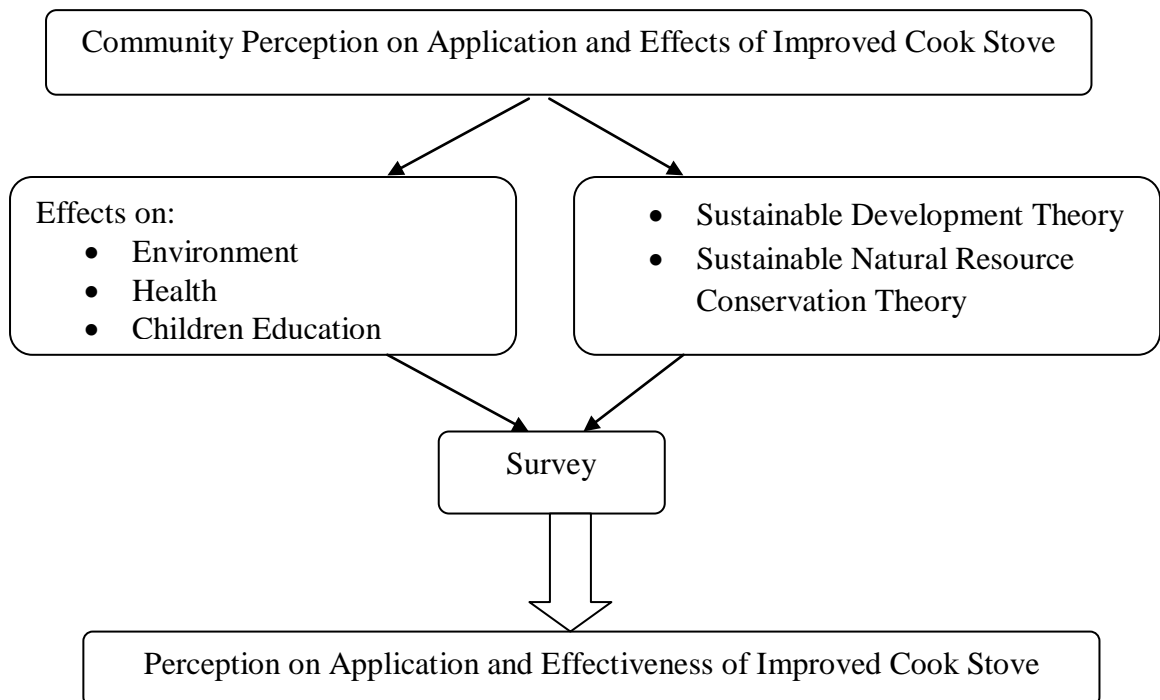


Figure 4. Conceptual framework.

### Chapter Summary

This chapter discussed the review of literature and has been divided into three parts, thematic, theoretical and past study review. Brief introduction of ICS and its history in Nepal are discussed in detail. Energy scenario of Nepal, potential of renewable energy technology, subsidy provision on ICS and its effects on



environment and health are outlined which has helped to give proper framework to the research questions. In addition to it, contribution of renewable energy technology in children education is discussed briefly. Theoretical review comprises of sustainable development theory and sustainable natural resource conservation theory. Study done in past on impacts of ICS in other districts like Baitadi, Dadeldhura, Kathmandu and Palpa are reviewed in this chapter. The chapter also includes the conceptual framework of the study which has contributed a lot to validate the research work academically.

## CHAPTER III

### METHODOLOGY

#### **Chapter Overview**

In this chapter, various aspects of research methodology are discussed. The chapter begins with the research method used in the study. Then what follows are the issues relating to research methodology such as the population and sampling, methods of data collection, tools of data collection, data analysis procedures and ethical issues concerning the study. To perform this research, various activities were carried out which include preparation of questionnaires, field visits as a part of preliminary survey to one VDC and one municipality of Kavrepalanchowk District and in-depth study of local people to generate related information essential for the analysis. Besides, baseline data from district profile of Kavrepalanchowk District was also taken into consideration to understand and visualize existing renewable energy scenario of the district. The following approaches were applied to complete the study.

#### **Research Design**

The study belongs to post-positivist paradigm. This research study examined community perception of ICS in terms of effects on environment, health and education in Kavrepalanchok District. These aspects were studied as evaluated by the community people, their perception on effects of ICS on environment, health and the contribution made on education of children. The study used survey (quantitative method) to find out community's perception. The required information and data was collected through questionnaire, during the field visit that describes the nature of the existing condition.

## Study Area

The study area of this project was selected in such a way that the data collected from this area would represent the ICS effects in rural areas of Kavrepalanchok District. The areas that were selected include one VDC and one municipality. The data was collected from different types of households like residential and commercial.

The basic reason for selecting the study site can be justified on the ground that it meets the large number of ICS installed VDC and municipality in the district. In addition installation program of ICS in Kavrepalanchok district has been more than 10 years, so this district can be considered as very good study area for people's perception regarding ICS.

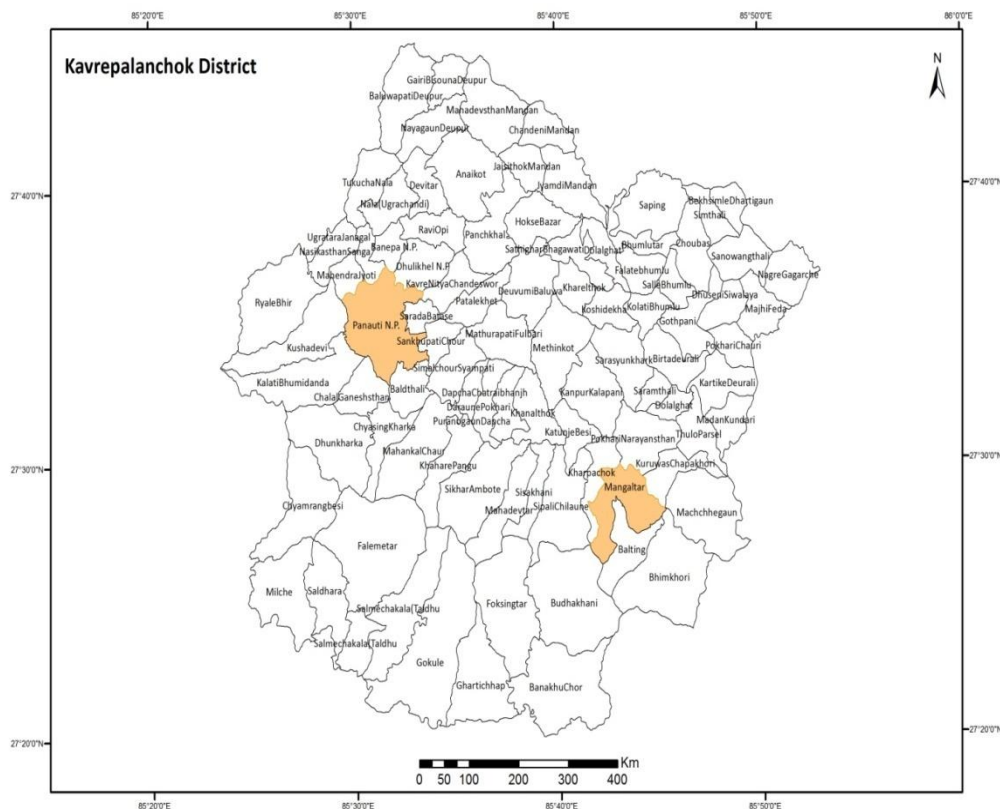


Figure 5. Sampling Area of Kavrepalanchok District (Source: Adapted from GIS, 2008).

### Instrumentation

A survey instrument is a tool for consistently implementing a scientific protocol for obtaining data from respondents. It involves a questionnaire that provides a script for presenting a standard set of questions and response options (Nusser & Mike, n.d.). The main theme of the research was to study the effects of ICS in environment, health and education aspects. Piloting was conducted with the help of instrumentation before conducting main survey in the field. The instrumentation of the study is shown as follows:

Table 4

Effects of Improved Cook Stove on environment, health and education

Environment	Consumption of fire wood	1	2	3	4	5
	Reduction in indoor air pollution	1	2	3	4	5
	Clean kitchen environment	1	2	3	4	5
Health	Changes or improvement in the illnesses after you establish ICS	1	2	3	4	5
	Reduction in eye irritation	1	2	3	4	5
	Improvement in throat infection	1	2	3	4	5
Education	No eye irritation	1	2	3	4	5
	No throat infection	1	2	3	4	5
	Changes or improvement in your health	1	2	3	4	5
	Improvement in your study	1	2	3	4	5

Note: 1- Strongly disagree, 2- Disagree, 3- Neutral, 4- Agree, 5- Strongly agree

### Sampling Design

Standard formulations were used for calculating parameters associated with statistical samples and populations (Kenkel, 1996). In general, the Gutman scale and

Likert scale were used in questionnaire. Gutman Scale was used to obtain for basic information which consists of binary value 1 for “Yes” answer and 2 for “No” answer. Similarly Likert scale expressed a range for given answers.

For the study participants were selected through purposive sampling methods. As survey was done on households possessing ICS gender was chosen as variable which would best stratify the participants given that the factor can play when discussing the effects of technology provided. Sample was taken based on universally accepted sample calculation formula. Sample size was determined by using 95% level of confidence and 0.05 level of significance. Based on universally accepted sample calculation formula, it is justified that taking 362 household represents the overall study area. The formula that was used for sample size is as follows:

$$n = \frac{z^2 pqN}{e^2(N-1) + z^2 pq}$$

Where,  $z=1.96$  at 95% confidence level,

$$p = 0.5,$$

$$q = 1-p,$$

$$e = 5\% \text{ i.e } 0.05,$$

$N =$  Total household of the study area.

Thus sample population of the study was 362. On the basis of sample, respondents were purposively selected from the sampling VDC and municipality.

Table 5

Sampling HH number for Questionnaire Survey

Site	Household Number with ICS	Sampling Household number
Mangaltar VDC	258	155
Panauti Municipality	451	207
Total		362

(Source: AEPC, 2013)

### Data Source

In this research data were collected from both primary and secondary data sources that were essential in preparing thesis report. The primary data was generated by direct survey with the family head of each family in study areas.

Secondary data was collected from various published or unpublished literatures and reference materials from concerned organizations. The secondary data was generated from organization like CBS, CRT, DDC, AEPC, REMREC, ENPHO, UNICEF and Practical Action. Besides several reports published in the relevant field and legislative literatures were also taken into consideration.

### Tools and Techniques of Data Collection

As the research focused on survey method, the tools of quantitative approach were valued. For the quantitative analysis, a structured questionnaire was carried out.

#### Primary Data Collection

For primary data collection, a structured questionnaire was carried out in the sampled households.

**Questionnaire development.** In development of questionnaire, draft questionnaire was prepared which was used for piloting in the study area. After piloting, questionnaire was finalized and was collected from study area. The

researcher visited one VDC and one municipality so that maximum number of data could be collected in limited frame of time.

**Sample household survey.** Survey was conducted in the sampled household that is the household possessing ICS by using the structured questionnaires.

Households in sample VDC and municipality of Kavrepalanchok district were surveyed in order to gather information for the study. It was used to find out people's perception and acceptance on ICS effects based on assessment of local people so far.

### **Secondary Data Collection**

Several literatures, published or unpublished, were used while conducting the analysis of data collected via questionnaire. Various relevant articles published via internet information and data collected from various organizations working in RE (Renewable Energy) sector such as CBS, CRT, AEPC, REMREC, ENPHO, UNICEF and Practical Action was used in making the study complete. For the purpose of collecting secondary data visits to the organization mentioned above was made.

### **Data Analysis and Interpretation**

Data analysis is very important as it has a specific bearing on the form of the instrumentation. So, researcher needed to plan the layout and structure of a questionnaire survey very carefully in order to assist data entry for computer reading and analysis; an inappropriate layout may obstruct data entry and subsequent analysis by computer (Cohen, Manion, & Morrison, 2007). Therefore, once field work was over, the data collected was studied for the further analysis and interpretations.

All the data and information collected from primary as well as secondary sources was compiled and systematically managed using computer softwares such as SPSS and Microsoft Excel, hence the data was processed, analyzed and interpreted. Various statistical tools like percentage, frequency and graphical representation were

used for the analysis of quantitative data. Moreover, tables, pie charts, bar-diagrams and pictures, photographs, etc. were used to make the analysis and presentation more understandable and easy. In addition inferential statistics were used as it allows us to use these samples to make generalizations about the populations from which the samples were drawn. In addition, it strives to make inferences and predictions based on the data gathered, for example, hypothesis testing, correlations, regression and multiple regression, difference testing (e.g. t-tests and analysis of variance, factor analysis, and structural equation modeling (Cohen, Manion, & Morrison, 2007). So SPSS was appropriate statistical tool that was used in my research. The results obtained from statistical analysis was also interpreted through descriptive method systematically.

### **Reliability and Validity**

Controlling all possible factors that threaten the research's quality is a primary responsibility of every good researcher. Therefore testing of validity and reliability of the instrument is important aspect for data collection and both are used to describe the accuracy and consistency of the data. As the philosophical orientation of the research is post-positivism, the quality standards were validity and reliability.

#### **Reliability**

Reliability is the synonym for dependability, consistency and replicability (Cohen, Manion, & Morrison, 2007). Reliability in quantitative analysis takes two main forms, both of which are measures of internal consistency: the split-half technique and the alpha coefficient. Both calculate a coefficient of reliability that can lie between 0 and 1. An alternative calculation of reliability as internal consistency can be found in Cronbach's alpha, frequently referred to simply as the alpha coefficient of reliability. The Cronbach alpha provides a coefficient of inter-item



correlations, that is, the correlation of each item with the sum of all the other items. This is a measure of the internal consistency among the items (not, for example, the people). It is the average correlation among all the items in question, and is used for multi-item scales. Therefore, alpha coefficient of reliability is appropriate for my research and SPSS was used in order to calculate Cronbach's alpha. The formula for alpha is:

$$\alpha = \frac{nr_{ii}}{1 + (n - 1)r_{ii}}$$

Where, n = the number of items in the test or survey (e.g. questionnaire) &  $r_{ii}$  = the average of all the inter-item correlations.

For the alpha coefficient the following guidelines can be used:

Table 6

Values and reliability scales for alpha coefficient

Values	Reliability scales
>0.90	very highly reliable
0.80–0.90	highly reliable
0.70–0.79	Reliable
0.60–0.69	marginally/minimally reliable
0.67 or above<0.60	unacceptably low reliability

Reliability level is acceptable at 0.8, although others suggest that it is acceptable if it is 0.67 or above (Bryman & Cramer ,1990,p.71 as cited in Cohen, Manion, & Morrison, 2007). Cronbach's alpha was calculated for the research and which was found to be 0.892. Much focus was given for the selection of sample size. To ensure the reliability of research tools, the findings from the study were checked again and again to minimize errors as far as possible.

## **Validity**

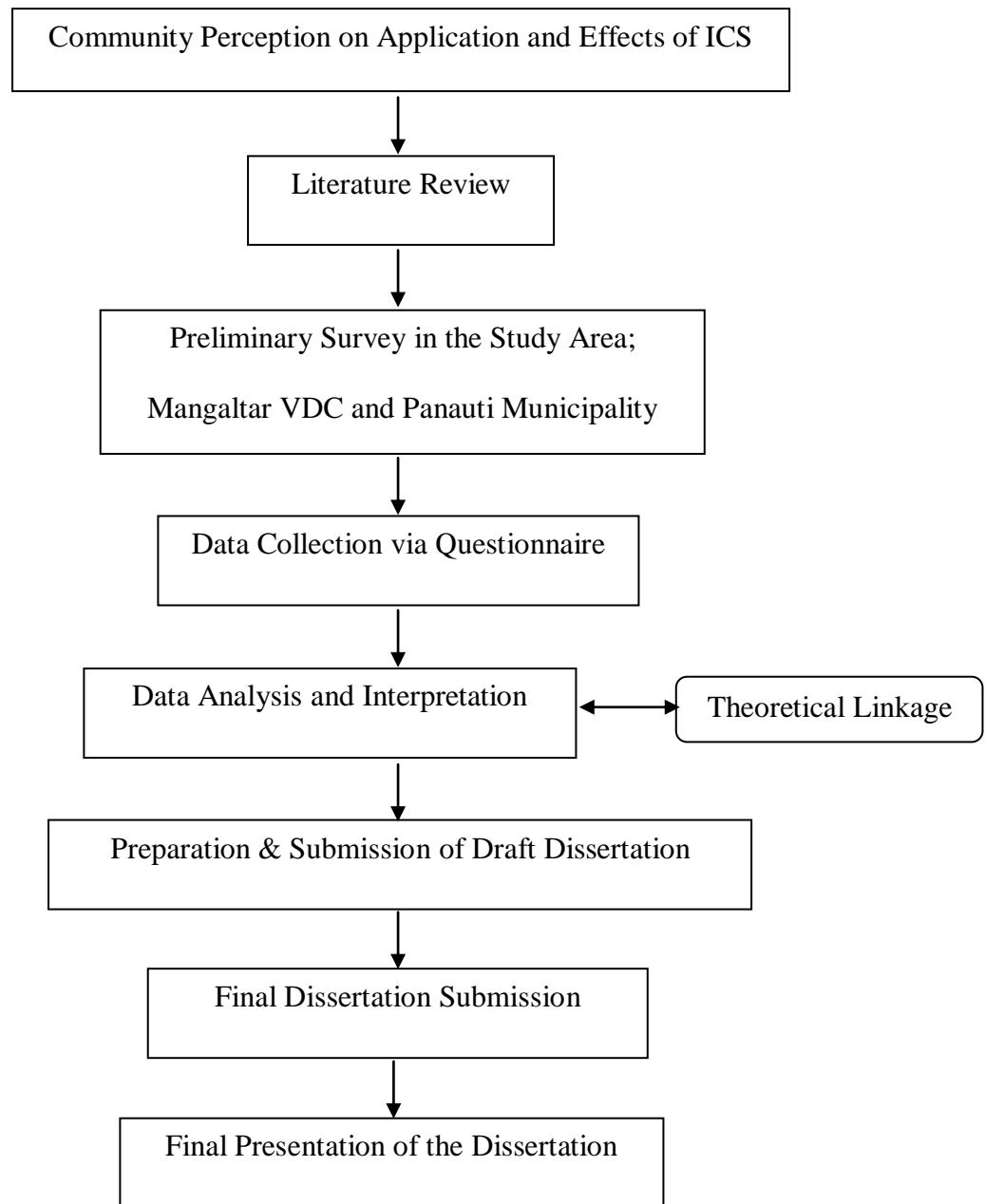
Validity is the key to effective research. Validity is the extent to which a test measures what it claims to measure. It is vital for a test to be valid in order for the results to be accurately applied and interpreted. Validity is not determined by a single statistic, but by a body of research that demonstrates the relationship between the test and the behavior it is intended to measure (Cherry, n.d). However validity of the research can be improved through careful sampling and statistical treatment of the data (Cohen, Manion, & Morrison, 2007). More specifically, validity depends both on the design and the methods of research. So validity is one of the main concerns that are needed to be addressed in research. Considering the research, internal validity is maintained by careful research design, subject population, and proper instrumentation. For maintaining external validity, population characteristics, interaction of subject selection and research, data collection methodology were carefully taken. So in this research, for ensuring content validity items that are rated as strongly relevant by judges were included in the final test. To assess the criterion validity of the test, pilot study was done. Higher the concurrent validity test higher will be validity if not then the research is flawed and needs a redesign (Green, 1955). Therefore focus was given on the degree to which a questionnaire or other measurement appears to reflect the variable it has been designed to measure.

In short as Reliability and Validity is concerned with the accuracy and consistency of measurement and is affected by survey design, sample representation and instrumentation. To obtain validity instrument must show that it fairly and comprehensively covers the domain or items that it purport to cover (Cohen, Manion, & Morrison, 2007). So with a view of ensuring quality focus was given on sample size, instrumentation, and piloting of the study.

### **Ethical Consideration**

Ethics is an individual belief or morality that states whether if behavioral actions are wrong or right. Various ethical issues come up at every stage of academic work and should be kept in mind while conducting the research. This study considered ethical issues during field work and during report writing stage. During the field survey, researcher kept in mind the perception of the local people. Being a part of the society, researcher was honest and maintained the secrecy and did not create any condition that could harm the respondents. Researcher made sure that there was no harm/disturbance to the respondents. In addition, during report writing ethical issues were considered by avoiding unethical practices like plagiarism.

### Schematic Representation of the Methodology Applied for the Dissertation



*Figure 6.* Schematic representation of the methodology for the dissertation.

### Chapter Summary

This chapter covers the whole methodological part of this dissertation. In this chapter, research method used and description of study area are discussed in brief. The chapter also includes the instrumentation of the study which has given guidance for piloting. Data source, tools and techniques of data collection are also discussed.

Similarly sample size calculation is shown in this chapter. Finally, data analysis, interpretation, quality standard of the study and ethical consideration along with schematic representation of the methodology applied are discussed briefly which has made this section academically reliable and authentic.

## CHAPTER IV

### RESULTS AND DISCUSSION

#### **Chapter Overview**

After the collection of data next step of the research is to present data and allow further analysis and discussion, so, this chapter describes the findings from study area and discussion on what respondents said in accordance with the findings. The research question, that is, effects of ICS on environment and health is addressed in this chapter. Contribution of ICS on children education and respondent perception on effectiveness of ICS are also discussed in this chapter.

#### **Socio-Economic Status of Study Area**

The socio-economic status of the people in the sampled household are discussed as below.

#### **Education Status**

Education is essential to understand the importance of alternative energy. Educational status in sampling VDC and municipality are shown in table 7. Overall literacy rate (for population aged 5 years and above) is 65.9 percent in Nepal with male literacy rate 75.1% compared to female literacy rate of 57.4% (CBS,2011). To know about educational status, it was differentiated into nine groups which is shown in table below. Majority of people in study area are found to be literate (i.e. those who can read and write), followed by illiterate which was then followed by other remaining categories. The educational status of the district is 69.8% (VDC and Demographic Profile of Nepal, 2013).

Table 7

## Education Status

<b>Education</b>	<b>Frequency</b>	<b>%</b>
Illiterate	182	16.74
Literate	265	24.38
Primary level	97	8.92
Lower secondary	86	7.91
Secondary	125	11.50
SLC (School Leaving Certificate)	119	10.95
IA (Intermediate Level)	137	12.60
BA (Bachelor Level)	62	5.70
MA (Master Level)	14	1.29
Total	1083	100

*Source: Field Survey, 2013*

**Occupation**

ICS has been used by the individuals of several occupations. For the same, data concerning occupation and ICS were collected and presented in Table 8. The table shows the variation in percentage of people involved in occupation in the study area. The occupation of the people is also one of the important components to get the statistics of different caste groups and their involvement in various occupations.

Table 8

## Occupational Status

<b>Occupation</b>	<b>Frequency</b>	<b>%</b>
Agriculture	413	38.13
Wages	34	3.14
Job	96	8.86
Business	48	4.43
Remittance	13	1.20
House wife	29	2.68
Student	446	41.18
In search of job	4	0.37
Total	1083	100

*(Source: Field Survey, 2013)*

In the study area eight different types of occupations were found. Besides student (41.18%), agriculture (38.13%) seemed to be the major occupation covering major portion percentage and job being the third one i.e. 8.8% similar to that of national report which indicates that major economy of the households is dependent on agriculture (CBS, 2011).

### Energy Scenario in Study Area

Energy consumption per month for different household activities like for cooking, cattle feeding and lighting are illustrated in the table below.

Table 9

Energy consumption per month for different HH activities in study area

<b>Firewood for cooking (GJ)</b>	<b>Firewood for cattle feeding (GJ)</b>	<b>Kerosene (GJ)</b>	<b>LPG (GJ)</b>	<b>Electricity (GJ)</b>
459.16	180.01	4.55	98.88	5.70

*Source: Field Survey, 2013*

From the above table it is clear that in the study area, for the cooking purpose 74.5% energy requirement was met by the use of firewood and LPG and for lighting 1.36% by the use of kerosene and electricity where as 24% energy for cattle feeding only by the use of firewood. This shows that firewood is the main source of energy for cooking and cattle feeding. For cooking purpose, firewood and LPG are used. Likewise for lighting, kerosene and electricity are used. Electricity is the main source of energy for lighting in Mangaltar VDC and Panauti Municipality.

Some calculation of energy consumption per month in the study area is shown in Annex C.



### Findings in Respective VDC and Municipality

Findings in Panauti Municipality and Mangaltar VDC such as characteristics of household, sources of firewood and reduction in firewood consumption by use of ICS are discussed in this section.

#### Household Characteristics

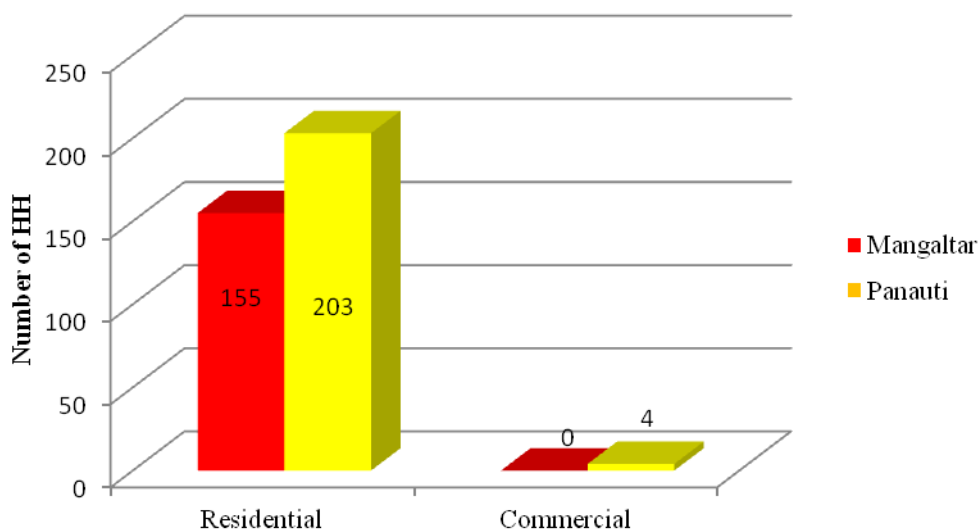


Figure 7. Sampling household types (Source: Field Survey, 2013).

In Mangaltar VDC, among 155 households, all of the households were residential households. There were no commercial and institutional households possessing ICS in the VDC. Whereas in Panauti Municipality, among 207 households, 203 households were residential households whereas 4 households were commercial. There were no institutional households possessing ICS in the municipality. Figure 8 shows the sampling household types in Mangaltar VDC and Panauti Municipality.

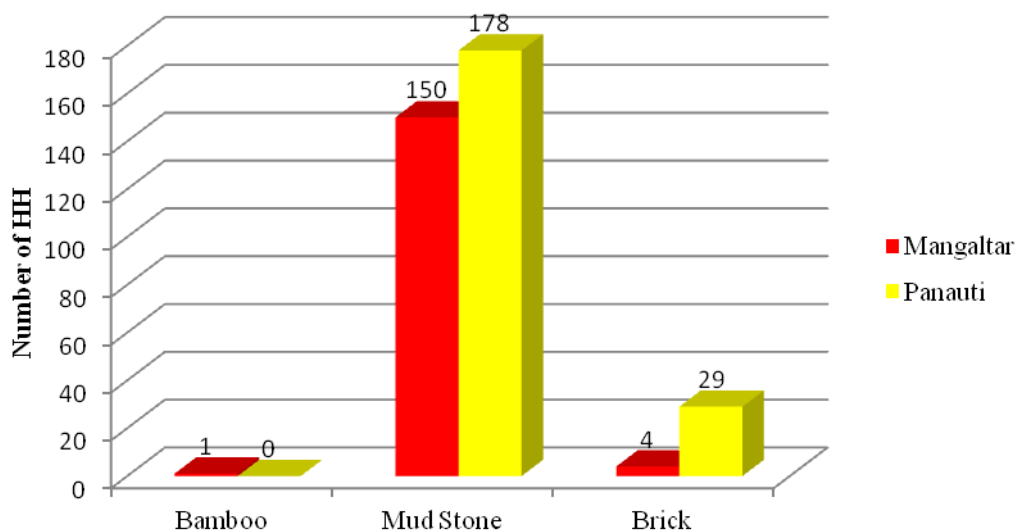


Figure 8. Wall types (Source: Field Survey, 2013).

In Mangaltar VDC, among 155 households, 150 households had wall made up of mud and stones. There were 4 households consisting of the wall made up of brick. Remaining households in sampling sites were made up of bamboo. Only locally available materials have been used to construct the walls. Moreover, because of poverty and lack of proper transportation facility the people living there cannot afford the cost of bricks to build the walls for their households, so, most of the household in Mangaltar VDC were made up of locally available materials.

Similarly in Panauti Municipality, among 207 households 86% households had walls made up of mud and stones. There were few households consisting of the wall made up of brick.

### Sources of Firewood

In total, there are 411 forest user groups in Kavrepalanchok District, so, most of the respondents prefer to use firewood from community forest. However, in Mangaltar VDC 59% respondents prefer to bring firewood from community forest. Few respondents collect firewood from government forest which is illegal. Although

it is illegal, government forest has been the source of firewood for the respondents in the VDC. About 7% respondents prefer bringing firewood from government forest, about 29% use private forest to obtain firewood and about 5% respondents bring firewood from various other sources like surrounding environment.

Likewise in Panauti Municipality, it was found that 61% respondents prefer to bring firewood from community forest. Few respondents collect firewood from government forest as well. About 6% respondents prefer bringing firewood from government forest, about 25% use private forest to obtain firewood whereas 8% respondents bring firewood from various other sources like surrounding environment.

Table 10

## Sources of Firewood

Sources of Firewood	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Government forest	11	7.10	13	6.28
Community forest	92	59.35	126	60.87
Private forest	45	29.03	51	24.64
Others	7	4.52	17	8.21
Total	155	100	207	100

*Source: Field Survey, 2013*

### Reduction in Fuel wood Consumption

The table below illustrates the reduction of firewood consumption by ICS compared to TCS in last five years in the study area.

Table 11

## Reduction in Fuelwood Consumption by ICS

	Mangaltar VDC	Panauti Municipality
Fuelwood Consumption by TCS(kg/month)	264	340
Fuelwood Consumption by ICS (kg/month)	104	125
Reduction (kg)	160	215
Reduction (%)	52.73	45.6

(Source: Field Survey, 2013)

From the survey it was found that 90% of the respondents believed that the use of ICS has consumed less firewood. In Mangaltar VDC, the consumption of fuel wood by ICS has been reduced by 160 kg/month than that of TCS. Similarly in Panauti Municipality, by the use of ICS fuel wood consumption has been reduced by 215 kg/month.

### Respondents Perception on RETs

Perception of the respondents in the study area on different types of RETs like ICS, MHP, biogas, solar energy are presented in this section.

### Understanding of RETs and Level of Knowledge

Table 12

## Understanding of RETs

Understanding of RETs	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Yes	149	96.13	191	92.27
No	6	3.87	16	7.73
Total	155	100	207	100

(Source: Field Survey, 2013)

Above table shows the people's perception on knowing RETs, which reveals that in study area majority of respondents were found to know about RETs where 6 percent in Mangaltar VDC and 7.7 percent in Panauti Municipality do not know about RETs though they are using it. In regard to question posed for type of RETs they know, the responses given for familiarity of RETs are shown in table below:

Table 13

## Response on Familiarity of Types of RETs

Familiarity of Types of RETs	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Solar lamp	1	0.65	2	1.04
ICS	44	28.39	143	75
Biogas, Solar, ICS, MHP	5	3.23	15	7.81
Solar and ICS	4	2.58	13	6.77
Biogas and ICS	6	3.87	16	8.33
MHP and ICS	89	57.42	0	0
Biogas	0	0	2	1.04
Total	149	100	191	100

(Source: Field Survey, 2013)

In the study area, majority of respondents are familiar about ICS i.e. 28% in Mangaltar VDC and 75% in Panauti Municipality. It might be due to fact that respondents are ICS users. After ICS respondents were well known about MHP and solar. To get knowledge on everything there requires proper information source so out of 149 people who know about RETs in Mangaltar VDC and 191 in Panauti Municipality they got information about these technologies mainly from their relatives or neighbors. As families and neighbors are the first things that come in contact with people so knowledge got transferred from those links. Local promoters, media and government organization/INGOs also played important role in promoting RETs in study area.

### Information of Stove

Different types of traditional stove were used by the community in the study area before the installment of ICS. Table 14 shows the types of stove used by the respondents before the installment of ICS and at present in the study area.

Table 14

Types of Stove Used Before ICS and Types of Stove Used at Present

Types	Before ICS				At present			
	Mangaltar VDC		Panauti Municipality		Mangaltar VDC		Panauti Municipality	
	N	%	N	%	N	%	N	%
TCS	153	98.71	197	95.17	1	0.65	1	0.48
Tripod Stove	0	0	2	0.97	0	0	0	0
Others	2	1.29	8	3.86	0	0	0	0
ICS	0	0	0	0	102	65.81	179	86.47
Biogas and ICS	0	0	0	0	47	30.32	17	8.21
ICS and LPG	0	0	0	0	4	2.58	7	3.38
ICS, LPG and Biogas	0	0	0	0	1	0.65	3	1.45
Total	155	100	207	100	155	100	207	100

(Source: Field Survey, 2013)

Before the installment of ICS, most of the households in study area used TCS.

It is obvious that people in both study area, one representing VDC and other municipality are changing their cooking behaviors by opting for better and improved technology like ICS, LPG, and Biogas over TCS. The efforts of various organizations like AEPC and other NGOs, INGOs in disseminating information and in raising awareness via organizing awareness campaigns should be credited for changing cooking behavior and practice of people in study area. Other than that gradual increment in literacy rate and income of people has also played its part in people selecting RETs over traditional energy sources in study area. The educational status of

the district is 69.8% (VDC and Demographic Profile of Nepal, 2013). Table 15 illustrates some of the reasons for people going for better technology over traditional technology.

Table 15

## Reasons for Shifting from Other Stove to ICS

Reasons for Shifting from Other Stoves to ICS	Mangaltar		Panauti	
	Frequency	%	Frequency	%
For income generation activities of promoter	1	0.65	1	0.49
Fuel wood consumption, Less smoke generation	68	43.87	83	39.81
Less cooking time	12	7.74	21	10.19
Clean kitchen environment	20	12.90	33	16.02
Due to interest	1	0.65	5	2.43
Due to more benefits	2	1.29	32	15.53
Improved health as no provision of smoke coming out	13	8.39	7	3.40
Easy to cook	27	17.42	25	12.14
No fire problem	11	7.10	0	0
Total	155	100	207	100

(Source: Field Survey, 2013)

The positive impacts of ICS on people in the study area on their day to day activities have added advantage over traditional cooking practices thus convincing people to use them instead of inefficient technology like TCS and tripod stoves. In reference to table 30, we can deduce that ICS definitely consumes less fuel wood and emits less smoke in the kitchen environment compared to TCS. Additionally it saves cooking time allowing people to engage in other day to day chores. Health is always a subject of utmost priority for human being. Therefore, using ICS seems to be better option for the community that relying on traditional form of energy for cooking purpose.

It is very important people that need to learn and understand routine maintenance and repair practice for better performance of ICS. Therefore, cleaning of chimney of stove, repair of minor breakages of ICS structure become essential. Table below illustrates how people in study area look after their ICS to maintain the cooking efficiency of ICS.

Table 16

## Maintenance of Stove by Respondents

Maintenance of ICS	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Sanitation	36	23.23	41	19.81
Litpot	14	9.03	63	30.43
No maintenance	1	0.65	15	7.25
Cleaning chimney in every 15 days	104	67.10	88	42.51
Total	155	100	207	100

*Source: Field Survey, 2013*

ICS needs to be maintained time to time for better and efficient performance in cooking. Data obtained from the study area show that people do value their property, thus, are well aware of regularly maintaining and repairing their ICS by following different practices like litpot, periodic cleaning of chimney, etc. It was surprising to know that few households were still unaware about maintaining their cook stove. In reference to interview with the respondent in respective study areas, it was found that people were so much engaged in income generating activities that they just could not manage regular time for proper maintenance and repair of ICS. Such respondents cited that it was a total waste of time involving themselves in maintenance of ICS as they could use that time to earn significant amount of money.



## Technical Aspects of ICS

Table 17

### Provision for Smoke Going Out of Kitchen

Provision for Smoke Going Out of Kitchen	Mangaltar		Panauti	
	Frequency	%	Frequency	%
Yes	153	98.71	206	99.52
No	2	1.29	1	0.48
Total	155	100	207	100

(Source: Field Survey, 2013)

According to survey it was found that in Mangaltar VDC, 99% of respondents believe smoke goes out of kitchen during functioning of ICS where as 1% say that there is no any provision of smoke going out of the kitchen. Similarly in Panauti Municipality, it was found that 99% of respondents believe smoke goes out of kitchen during functioning of ICS where as 1% say that there is no any provision of smoke going out of the kitchen.

Technologies are meant to reduce the drudgery of people in their day to day activities. Therefore, technologies must be able to satisfy the user for significant period of time. The table below shows the result of level of satisfaction of ICS users with the technology.

Table 18

## Satisfaction Level of User

		Mangaltar VDC		Panauti Municipality	
		Frequency	%	Frequency	%
Satisfaction	Yes	154	99.35	206	99.52
Level of	No	1	0.65	1	0.48
ICS User	Total	155	100	207	100

(Source: Field Survey, 2013)

Till this date, no advanced technology has been introduced for general people that have got superior quality to ICS in terms of efficiency. So, existing technology devised for cooking is better option to reduce their cooking drudgery. From the survey it is clear that majority of respondents are satisfied with the technology they are using for cooking as better alternative for ICS has not yet been disseminated within the reach of general people.

### People's Perception about the Effect of ICS on Environment

Success or failure of technology depends on people's perception on the technology. Therefore it is essential to explore the opinion on usage of ICS and its effects on different aspect of environment and health.

Table 19

Effects of ICS on Forest and Environment Conservation

Effects of ICS on Forest and Environment Conservation	Mangaltar VDC (%)			Panauti Municipality (%)		
	Very good	Normal	No effect	Very good	Normal	No effect
Less firewood consumption	26.1	58.2	15.7	46.4	48.3	5
Minimize in deforestation	65.4	15.7	19	27.5	47.8	24.6
Conservation and enhancement of biodiversity	43.1	24.2	32.7	16	27.2	56.8
Assurance of green environment	65.4	12.4	22.2	15.5	28.5	56
Prevention of natural disaster like flood	52.6	26.3	21.1	11.7	30.1	58.3
Cost reduction in afforestation program	32.9	36.8	30.3	14	29	57
Reduction in indoor air pollution due to smoke	69.9	9.8	20.3	25.6	25.6	48.8
Clean and healthy environment	66	13.1	20.9	28	24.2	47.8

(Source: Field Survey, 2013)

People's perception on ICS effect on environment and forest conservation observed is shown in table above. Consumption of firewood is reduced by the use of ICS as compared to traditional cook stove. As already discussed fuel wood consumption has reduced by 53% in Mangaltar VDC and similarly by 46% in Panauti Municipality. Less consumption of firewood means conservation of forest

resources which ultimately minimizes natural calamities like landslide, soil erosion, etc assuring greenery of the surrounding neighborhood. The data also shows that there have been good effects of ICS on reduction in indoor air pollution as the chimney of ICS ensures the release of smoke out from the kitchen.

### People's Perception about the Effects of ICS on Health of People

Health is one of the aspects on which ICS has an effect. RETs like ICS should always prioritize health of the user. Table 20 illustrates ramification of using TCS prior to use of ICS in the health of the user.

Table 20

Illness Caused by Smoke from Indoor Air Pollution and the Sufferer of it

		Mangaltar VDC		Panauti Municipality	
		Frequency	%	Frequency	%
Illness Caused by Smoke from Indoor Air Pollution	Chronic Obstructive Pulmonary Disease	24	15.48	90	43.4
	Headache	62	40	72	34.7
	Conjunctivities	27	17.42	27	13.0
	Cataracts	0	0	3	1.45
	Mental health	1	0.65	1	0.48
	Others	39	25.16	1	0.48
	Headache, Conjunctivities	2	1.29	13	6.28
	Total	155	100	207	100
Sufferer from Indoor Air Pollution	Women	132	93.55	117	56.5
	Women and Children	23	6.45	90	43.4
	Total	155	100	207	100

(Source: Field Survey, 2013)

Incomplete combustion of fire wood leads to emission of CO which is the main constituent of smoke along which black soot. The smoke emitting from the TCS

thereby, is the main source of health hazard on the user. All the above mentioned health hazards are due to either inhaling the smoke or due to direct exposure to the smoke. Women along with their toddlers are active members of family who take the responsibility of cooking and spend more time in the kitchen. They are the ones who are vulnerable to above mentioned health hazards.

The respondents reported that use of ICS has minimized the health hazards which have been mentioned in table 5.14 to some extent. Table below shows the changes or improvement in health problem mentioned by the respondents after the installation of ICS.

Table 21

People's Perception about the Changes or Improvement in Health Problem after ICS Installation

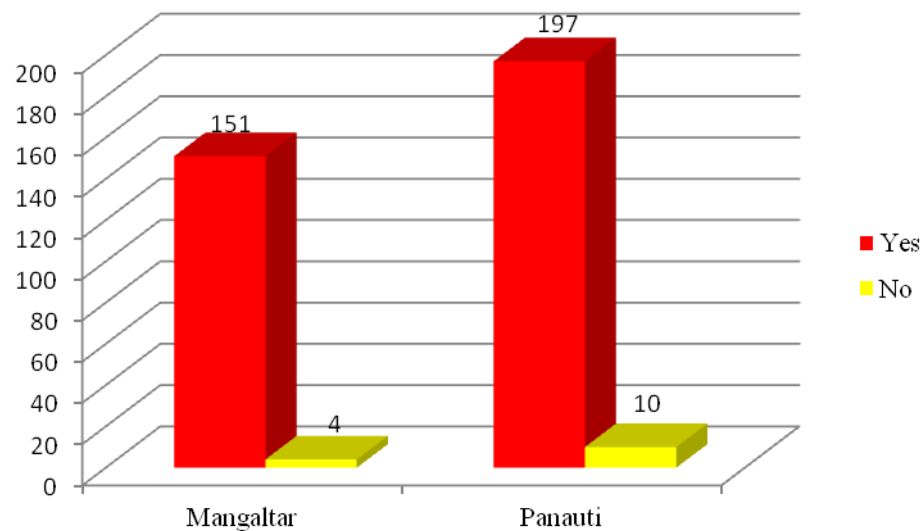
Improvement in Health Problem after Installment of ICS	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Yes	145	93.55	198	95.65
No	10	6.45	9	4.35
Total	155	100	207	100

(Source: Field Survey, 2013)

Respondents were found to claim that there has been significant improvement in their health after the installation of ICS. Due to smoke free indoor environment people in study area believe that their health has been improved after the installation of ICS. People with the eye problems like conjunctivitis and cataracts say that this problem has been reduced because the smoke is ventilated out from the chimney and thus eye is saved from smoke. However, there were few respondents who do not believe ICS leads to improvement on the health of ICS user.

### Contribution of ICS on Children Education

As the study already discussed that the use of ICS is beneficial in terms of having extra time for the users who can engage themselves in other activities like facilitating in education of their children. Figure below demonstrates the contribution of ICS on the children education.



*Figure 9.* Contribution of ICS on children education (Source: Field Survey, 2013).

The use of ICS has contributed a lot on education of children. Among 155 respondents in Mangaltar VDC, 97% reported that ICS has helped in their children's education. Likewise among 207 respondents in Panauti Municipality, 95% reported that ICS has helped in their children's education.

There are certain parameters based on which the study advocates the contribution of ICS on children education. Some of those parameters have been listed in table 22 given below.

Table 22

## Effects of ICS on Children Education

Effects of ICS on Children Education	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Study in smokeless environment	1	0.66	15	7.25
Time saved to study	3	1.99	20	9.66
No eye irritation during study	38	25.1	8	3.86
Food is cooked on time and children can go to school on time	10	6.62	83	40.1
Improved health of children as compared to normal stove	32	21.1	38	18.3
Development in child study	29	19.2	5	2.42
No obstruction in child study during cooking food	35	23.1	1	0.48
Motivated to study	3	1.99	37	17.8
Total	155	100	207	100

(Source: Field Survey, 2013)

ICS assures smokeless environment in which children can study in clean environment without any health hazards. Additionally cooking time is also reduced in ICS, thus food is cooked relatively faster as compared to TCS. This enables children to have their food on time and head towards their school. This eventually motivates children to efficiently continue their study.

### People's Perception and Articulation on Effectiveness of ICS

Table 23 shows respondent articulation on the effectiveness of ICS in the study area.

Table 23

#### Respondent Articulation on Effectiveness of ICS

Effects of ICS	Mangaltar VDC		Panauti Municipality	
	Frequency	%	Frequency	%
Less fuel wood consumption	5	3.23	46	22.22
Easy to use	17	10.97	68	32.85
Time consuming	13	8.39	9	4.35
Clean kitchen environment	11	7.10	33	15.94
Involvement of other house member in kitchen	1	0.65	9	4.35
Improved health	8	5.16	8	3.86
Forest conservation	77	49.68	24	11.59
Assurance of greenery	23	14.84	10	4.83
Total	155	100	207	100

(Source: Field Survey, 2013)

From the field survey in Mangaltar VDC it was found that almost 50% of the respondents believed that use of ICS has conserved forest as using this improved form of cook stove has consumed less firewood, thus, conserving forest and assuring greenery. They believed that their time has been saved and had positive effects on health ever since they used ICS. About 11% respondents found ICS an easy technology to cook food. 1% of the respondents believed that use of ICS has engaged



other member of house in kitchen activities because unlike TCS, ICS emit the smoke out of the kitchen keeping the kitchen environment clean.

Likewise in Panauti Municipality, 33% of the respondent believed that ICS is one of the easy technologies to use for cooking food. 12% believed that use of ICS has helped in conserving forest. They believed that their time has been saved and had positive effects on health ever since they used ICS. 4% of respondent believed that use of ICS has helped to involve other house member in kitchen activities since unlike TCS, ICS emits the smoke out of the kitchen keeping the kitchen environment clean.

### **Chapter Summary**

Chapter IV covers the result and discussion part of the study. The research question of the study i.e. effects of ICS on environment and health, its contribution in children education has been addressed in this chapter. Also the respondent perception on effectiveness of ICS has been discussed in this chapter.

## CHAPTER V

### SUMMARY OF FINDING, DISCUSSION, CONCLUSION AND RECOMMENDATION

#### **Chapter Overview**

In this chapter, the researcher has clearly discussed the key points of the study. The study conducted in Mangaltar VDC and Panauti Municipality of Kavrepalanchok district reveals that use of ICS has made positive effect on environment and health and it has also contributed a lot in educational aspects. This chapter also concludes with people's perception on effects of ICS on environment and health aspects. It also signifies contribution of ICS on children education and the user perception on effectiveness of ICS. This chapter acknowledges how the study can be useful for promotion of sustainable technology and opens new window for other researchers.

#### **Key Findings**

The objective of this study was to find out the effects of Improved Cook Stove in Panauti Municipality and Mangaltar VDC of Kavrepalanchok district in Nepal. The finding of research have been presented according to the research questions.

#### **Effects of ICS on Environment**

To find out perception of local people towards ICS effects on environment, indicators like firewood consumption, reduction in afforestation program and maintenance of clean and healthy kitchen environment were used in household survey. According to research results in Mangaltar VDC 84 percent of the respondents believed that the use of ICS has helped to consume less firewood similarly in Panauti Municipality 95 percent respondents believed that the use of ICS has helped to consume less firewood.

Regarding reduction of cost in afforestation program, it was found that 70 percent in Mangaltar VDC and 43 percent in Panauti Municipality agree with cost reduction in afforestation program by the use of ICS.

80 percent of respondents in Mangaltar VDC concur that ICS has helped to maintain clean and healthy environment. Whereas in Panauti Municipality, 52 percent agree that ICS has helped in maintaining clean and healthy environment.

### **Effects of ICS on Health of People**

In terms of ICS effect on health of people, 94 percent of respondents in Mangaltar VDC and 96 percent in Panauti Municipality show improvement in health by use of ICS as compared to TCS. The study reveals that the problem related with eye, lung and headache by the smoke generated from TCS has been improved by the use of ICS.

### **Contribution of ICS on Children Education**

In terms of children education there is good contribution of ICS use. The study reveals that in Mangaltar VDC and Panauti Municipality respectively, 85 percent and 93 percent respondents agreed with reduction in eye irritation to their children during study time. The respondents also showed agreement on no throat problems. 7 percent in Mangaltar VDC and 40 percent in Panauti Municipality said that ICS is less time consuming and user get more time to prepare their children for school.

### **People's Perception and Articulation on Effectiveness of ICS**

From the field survey in Mangaltar VDC and Panauti Municipality, it was found that almost 50 percent and 12 percent respondent respectively believed that use of ICS has conserved forest and maintained greenery.

Furthermore, 11 percent of respondent in Mangaltar VDC and 33 percent in Panauti Municipality found ICS to be easy in handling in comparison to TCS while cooking food.

In addition to it, 1 percent of respondents in Mangaltar VDC and 4 percent in Panauti Municipality believed that use of ICS has assisted in participation of other family members in kitchen activities.

### **Discussion of Findings**

The discussion of the key findings that address the research questions of this dissertation are discussed as follows.

#### **People's Perception on Effects of ICS on Environment**

The study shows that the fuel wood consumption by ICS in Mangaltar VDC is less as compared to that of Panauti Municipality. This might be due to the reason that in VDC the fire wood is used not only for cooking food in ICS but is also used in open fire whereas in the municipality fire wood is used only in ICS for cooking food. So comparatively fuel wood consumption is reduced more in the municipality. The theoretically estimated sustainable annual yield of fuel wood in Nepal is 25.8 million tonnes per ha of forest. However, only 42% or 10.8 million tonnes, of the theoretically sustainable supply are accessible (Rijal, 1998). Fuel wood supplies almost 80% of total energy demand of Nepal (Nakarmi, 2002) so in the study area fuel wood is the main source of energy for cooking purpose. One of the studies done by CRT in Baitadi and in Dadledhura districts on impacts of ICS reported that ICS has saved 29% of fuelwood which can be concluded as majority of users has saved significant amount of fuelwood (CRT, 2002).

Afforestation program is more in VDC area and less in Municipality. As a result people have perceived that cost reduction in afforestation program in Panauti Municipality is low while in Mangaltar VDC it is more.

In the study area maintenance of clean and healthy kitchen environment is more in VDC as compared to Municipality. This might be the reason Municipality people are used to staying in clean kitchen environment. ICS can do much to reduce the pollution levels in the kitchen, as well as to maintain cleaner kitchen environment. They also reduce women's work burden and give them a sense of modernity and increase their sense of wellbeing (AEPC, 2008). Moreover, in the Municipality kitchen is well ventilated to maintain sufficient air flow due to height of kitchen and more windows. Some people in Municipality even use LPG for cooking food. As a result not so high value is seen in this context. Whereas in VDC the kitchen structure generally has less height with small window and congested area leading to high value of IAP. As such when maximum smoke is directed out of kitchen, clean environment becomes more vivid.

In this context it can be concluded that majority of users in both Mangaltar VDC and Panauti Municipality has saved significant amount of fuel wood as compared to that of TCS. That is why ICS has better effect for the conservation of fuel wood and ultimately forest and environment.

### **People's Perception on Effects of ICS on Health**

Indoor air pollution is one of the prominent health issues. ICS reduce all the disease that are caused by the smoke such as eye problems, cough, asthma, ARI by removing out smoke from the kitchen. Most of the ICS users have got smoke free kitchen environment after the installation of ICS leading to reduced health problems due to smoke (CRT, 2002). ICS has improved the indoor air environment by

removing the smoke out from the kitchen and decreased health expenditure as there was reduction of illness and fire hazards in the community. Cleaner use of traditional fuels can significantly improve health by reducing acute respiratory infection and conjunctivitis, commonly caused by indoor air pollution (Murphy, 2001). Health hazards of the people such as headache, eye related diseases and lungs diseases were controlled by the use of ICS.

### **People's Perception on Contribution of ICS on Children Education**

People of study area felt ICS contribution on children education. There were reduction in eye and throat irritation of children during study time due to less smoke in kitchen as smoke is removed out from the kitchen. According to AEPC, use of ICS has diminished fewer respiratory diseases particularly lower respiratory infection such as pneumonia among children and COPD among women. Improved health, motivation in children study is some of the effects of ICS on children education.

ICS cooks food faster (in less time than TCS) so the users of ICS get more time to prepare their children for school. Wider health benefits can occur too; cooking with more efficient technologies can make dietary choice and boiling of water more affordable or more likely. Women and children in particular have more time for education, leisure and economic activity (Murphy, 2001).

However, few of the respondents in the study area strongly disagreed with contribution of ICS on their children's study.

### **People's Perception and Articulation on Effectiveness of ICS**

In terms of people's perception and articulation on effects of ICS the study shows that majority of the respondents in Mangaltar VDC reported that use of ICS has contributed to the conservation of forest. This might be the reason that supply of fire wood is actually from VDC. People from Panauti Municipality purchase fire wood

brought from VDC. Due to this reason large impact of forest conservation is seen in Mangaltar VDC. By the use of Improved Cook Stove, fuel wood consumption has been reduced by about half as compared to that of Traditional Cook Stove. Study has shown that Greenhouse Gas Emissions have been reduced by about 2.5 ton CO<sub>2</sub> per year per stove (AEPC, 2008).

From the study it is also clear that both VDC and Municipality found ICS as easy handling which might be due to reason that in ICS fire wood is combusted better than TCS.

Participation of other people in kitchen activities seems to be increased in Panauti Municipality than VDC due to cleaner kitchen environment as discussed earlier unlike TCS; ICS emits the smoke out of the kitchen keeping the kitchen environment clean. So from this study it can be concluded that use of ICS has shown good demonstration and articulation on its effect to the community.

### **Conclusion**

Based on the findings several conclusions are drawn. Different types of ICS are used in Kavrepalanchok district like One pot hole, Two pot hole and Rocket Stove among which One pot hole are most widely used.

From this study it is clear that use of ICS has made positive effects on environment and health and has contributed a lot in educational aspects of children. From the perspective of effects on environment, ICS in the household has contributed positive effect in relation to reduction in fuel wood consumption, reduction in cost of afforestation, reduction in IAP and thus maintaining the clean kitchen environment in both the study areas. It is clear that use of ICS has reduce IAP in particular and support in protection of natural environment in general.

Another key finding regarding the benefit of use of ICS is the positive impact on improvement in health quality. Positive effect on health quality such as reduction in problems related to eyes, lungs and headache has been observed. It is obvious that the reduction in IAP has helped to minimize the health problem related to respiratory diseases particularly to the women and children who are mostly exposed to IAP while cooking food. In addition, the expenditure incurred for health problem has also curtailed due to decrease in IAP.

Moreover there is good contribution of ICS use in children education. From the research it is clear that there is no problem related to eye in children during their study time. Most of the respondents agree that there is no throat problem to their children, thus, improving the health of children. Improved health, motivation in children's study are some of the effects of ICS on children education. Some of the respondents said that ICS is less time consuming and their children can go to school on time as the food is cooked on time. However, few of the respondents strongly disagree on contribution of ICS on their children's study.

It is clear that ICS has helped to conserve forest as using improved form of cook stove has reduced firewood consumption thus having positive effect on forest and assuring greenery. Furthermore, respondents believed that time spent in household chores (specially cooking) has been drastically reduced and has positive effects on health ever since they used ICS. Respondent also reported ICS as easy handling while cooking food. In addition, use of ICS has engaged other members of house in kitchen activities. So from this study it can be concluded that use of ICS has shown good effect to the community.



### **Recommendation**

The study tries to find the local people's perception on ICS contribution in environment, health and education in one VDC and one Municipality of Kavrepalanchok district of Nepal which was evaluated paying particular attention to their perception on reduction in fuel wood consumption, reduction in IAP, improvement in health and contribution perceived on education.

#### **Policy recommendation**

- i. The programs and policies should not only be documented but also has to be disseminated and properly implemented and need to have sustainable focal point.

#### **Recommendation to I/NGOs**

- i. Refresher of awareness and capacity building programs should be done as rural people cannot expand their horizon on their own regarding technological matter.
- ii. Proper monitoring and evaluation of the technology disseminated should be done on regular basis by implementing agencies (AEPC at national level and RSC/NGO in local level) in order to ensure well functioning of ICS.
- iii. Proper human power development through trainings should be encouraged so that local people themselves can learn to repair minor breakdown of ICS being used in their households.

#### **Recommendation to future researchers**

- i. Efficiency of ICS is comparatively lower compared to that of other biomass energy technology. Efficiency of ICS should be increased through modification in design and should be cost effective as well so that the local community can afford it easily.

- ii. Research and development by university and other research organization should be done to modify the design of ICS for increased efficiency.

As the main objective of social science research is to seek community or local development, this study talks about renewable energy technology, particularly, ICS and its effects so the finding of the study also can open windows for other researchers who want to work on the similar fields using other methodological options.

### **Chapter Summary**

Chapter V has presented the summary of this dissertation. Addressing the research questions of the study, the researcher has summarized the discussion in the chapter. In addition to it, output of whole research work was presented in this chapter with proper conclusions and some recommendations. This research will contribute knowledge in the field of sustainable development in general and renewable energy in particular.

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## ANNEX A: RESEARCH QUESTIONNAIRE

**Community Perception on Application and Effects of Improved Cook Stove:****Contribution to Environment, Health and Education****Household Data Collection Questionnaire**

House hold survey No.....	Ward No. ....	Date.....
Village/Tole.....	VDC/NP.....	
( ) Residential	( ) Commercial	( ) Institutional

**1. Respondent's Personal Information**

Name (optional)/ Caste					
Education	1. Literate	2. Illiterate	3. Educated		
Family Size	1. Female.....	2. Male.....	3. Total.....		
Religion	1.Hindu	2.Muslim	3.Buddhist	4.Christian	6.Others
Main Occupation					

**2. Family Information**

S. N.	Relation with the Family Head*	Age	Education#	Occupation\$

\*1. Family Head                      2. Husband/Wife                      3. Son/Daughter                      4. Father/Mother

5. Daughter in law                      6. Father in law/Mother in law

7. Grandson/ Grand daughter                      8. Others

#1. Illiterate                      2. Literate                      3. Primary                      4. Secondary                      5. S.L.C

6. I.A or equivalent                      6. B.A or equivalent                      7. M.A or equivalent

8.Above M.A

\$1. Agriculture                      2. Wages                      3. Job                      4. Business                      5. Foreign Affair

6. House wife                      7. Student                      8. In search of job                      9. Others

### 3. Condition of house

3.1 Do you have your own house?

1 Yes            2 No            3 Rent

(If answer is 2 then go directly to Q.N. 4)

3.2 If yes then what is the condition of house?

Description	Type	Remarks
1 Storey	Roof/one/two/three/above three	
2. Roof type	Straw/Slate/Tin/R.C.C	
3 Wall type	Bamboo/Mud Stone/Brick	
4 Building Condition	New/ Old/Just maintain	

### 4. Drinking water and Sanitation

4.1 What is the source of drinking water?

1. Well      2. Community Tap      3. Private Tap      4. Pump      5. Stream  
6. Other

### 5. What is the source of your family earning?

1. Agriculture      2. Service      3. Wages      4. Remittance      5. Business  
6. Pension      7. Others

### 6. Knowledge on alternative energy

S. No.	Questions	Coding categories
6.1	Do you know about alternative energy?	1. Yes 2.No
6.2	What alternative energy sources do you know?	1.Biogas 2.Solar PV 3.Solar water pump 4.Solar dryer 5.Solar cooker dryer 6.ICS 7.Micro hydro 8.Others
6.3	How do you come to know about this technology?	1.Relatives/Friends 2.Neighbour 3.Media 4.Promotion center 5.Newspaper/Bulleting 6.Others

### 7. Stove Information

7.1 What type of stoves do you use?



1.TCS

2. ICS

3. Biogas

4.Others

7.2 Who built this stove and when?.....

7.3 How much did it cost? .....

7.4 How is it maintained? .....

7.5 What type of stove did you use before installation of ICS? .....

7.6 What is the reason that made you shift from other stove to ICS?  
.....

No.	Questions	Coding categories
7.7	Who does the cooking work?	1. Mother    2.Daughter 3.Father    4.Son 5.Other
7.8	Number of people for whom food is cooked?	1.1-5        2. 5-10 3.Above 10
7.9	For what purpose is the stove used?	1.For cooking meal for morning time 2.For cooking meal for morning and evening 3.For other purposes like food stuffs for animals
7.10	What are the types of pots used?	1.Metal 2.Clay
7.11	Is there any provision for the smoke going out?	1.Yes 2.No
7.12	Are you satisfied with this cooking stove?	1.Yes 2. No
	If yes then what are the reasons for satisfaction	1.It gives more/less smoke 2.Fuel wood more/less used 3.More/less eye irritation and throat irritation 4.Food will be cooked in more/less time 5.It is more/less tastier 6.Kitchen remains more/less clean 7.Others
	If no then what are the reasons for dissatisfaction	1.Expensive 2.Distant market 3.Not available when required 4.Scarcity 5.Others

### 8. Information of energy used (per month)

Description	For cooking food	For animal food	Lightening	Other purpose	Cost (per Unit)
Fire wood (Bhari)					
Cow dung (Doka)					
From field					
Kerosene (Liters)					
LPG (Cylinder)					
Electricity (Unit)					
Battery					
Diesel					
Other* .....					

\* .....

### 9. If fire wood is used, from where do you get?

1. Walking distance from government forest? .....Hours
2. Walking distance from community forest?.....Hours
3. Walking distance from private forest?.....Hours
4. If others, give detail .....Hours

S. No.	Questions	Coding categories
10.1	What was the income source to install ICS?	1.Own property 2.Government subsidy 3.Loan from bank 4.Cooperative Pvt Ltd 5.Others
10.2	If managed on own, how did you manage?	1.Private saving 2.Loan 3.Family saving 4.Remittance 5.By selling property 6.Others
10.3	Was there any difficulty in paying back loan?	1.Yes 2.No

10.4	Did you get any subsidy?	1.Yes Subsidy Amount..... 2.No
10.5	Who gave the subsidy?	1.Government 2.NGO 3.Others
10.6	Are you satisfied with the subsidy provision?	1.Yes 2.No

## 11. Effects of ICS

### 11.1 What are the benefits of ICS on forest and environment conservation?

S. No	Benefits	Impact		
		Very good	Normal	No effect
1.	Less firewood consumption			
2.	Devrease in deforestation			
3.	Conservation and enhancement of biodiversity			
4.	Assurance of green environment			
5.	Prevention of natural disaster like flood			
6.	Cost reduction in afforestation program			
7.	Reduction in indoor air pollution due to smoke			
8.	Natural balance in ecosystem			
9.	Clean and healthy environment			

### 11.2 Effects of ICS on health of people

No.	Questions	Coding categories
1.	In your opinion what illness are caused by the smoke from fuel wood or indoor pollution?	1. Chronic Obstructive Pulmonary Disease 2. Headache 3. Conjunctivitis 4. Cataracts 5. Mental health 6. Others
2.	What are the most common illness or health problems that are found in your cluster?	1. Chronic Obstructive Pulmonary Disease 2. Headache 3. Conjunctivitis 4. Cataracts 5. Mental health 6. Others
3.	Who are suffering especially from them?	1. Men 2. Women 3. Boys

		4.Girls
4.	According to you, have there been any changes or improvement in the illnesses you mentioned after the establishment of ICS?	1. Yes 2. No
	If yes then rate the improvement level	1.Better 2.Good 3.Fair 4.To some extent
5.	Has there been any reduction in maternal health?	1. Yes 2. No
	If yes then rate the improvement level	1.Better 2.Good 3.Fair 4.To some extent

### 11.3 Contribution of ICS on children education

Has ICS helped in children education?

1. Yes            2. No

If yes then rate the benefits on children education

S.No.	Benefits	Effects				
		Strongly Agree	Agree	Normal	Disagree	Strongly Disagree
1.	No eye irritation					
2.	No throat infection					
3.	Changes or improvement in their health					
4.	Improvement in their study					
5.	Motivation in their study					

What are the other contributions made by ICS on children education?

.....

12. Does ICS have effects on your house?

1. Yes            2. No

If yes then what are they?

.....

13. Is there any suggestion to promote ICS in community and village?

.....

**ग्रामीण नेपालमा सुधारिएको चुलोको प्रभाव सम्बन्धी अध्ययन: बातावरण,  
स्वास्थ्य तथा शिक्षामा देन  
घरघुरी तथ्याङ्क संकलन प्रश्नावली**

प्रश्नावली नं.....	वडा नं.....	मिति.....
गाउँ टोल.....	गाविस/न.पा. ....	
( ) घरायसी	( ) व्यापारिक	( ) संस्थागत

**१. उत्तरदाताको व्यक्तिगत विवरण**

नाम थर						
शिक्षा	१. साक्षर		२. निरक्षर			
परिवार संख्या	१. महिला.....		२. पुरुष.....		३. जम्मा.....	
धर्म	१. हिन्दू	२. मुस्लिम	३. बौद्ध	४. एसु	५. अन्य	
मुख्य पेशा						

**२. पारिवारिक विवरण**

क्र.सं.	परिवारमूलीसँगको नाता*	उमेर	शिक्षा# (५ वर्ष वा सो भन्दा माथिको लागि मात्र)	पेशा\$

\* १. परिवारमूली    २. श्रीमान/श्रीमति    ३. छोरा/छोरी    ४. बाबू/आमा    ५. बुहारी

६. सासू/ससुरा    ७. नाति/नातिनी    ८. अन्य

# १. निरक्षर    २. साक्षर    ३. प्राथमिक तह    ४. निम्न माध्यमिक तह    ५. माध्यमिक तह

६. एस.एल.सी. पास    ७. आइ ए वा सो सरह    ८. वि.ए वा सो सरह

९. एम.ए. वा सो सरह    १०. एम.ए. भन्दा माथि

१. कृषि      २. ज्यालादारी/मजदूरी      ३. नोकरी (३.१ सरकारी ३.२ मा निजि तथा संस्थान)
४. व्यापार व्यवसाय      ५. वैदेशिक रोजगारी      ६. गृहणी घरधन्दा      ७. विद्यार्थी      ८. कामको खोजी      ९. अन्य

### ३. घरको भौतिक अवस्था

३.१ तपाईंको आफ्नो स्वामित्वमा घर छ ?

१. छ      २. छैन      ३. भोग चलनमा रहेको तर स्वामित्वमा नरहेको

(कोड २ उत्तर आएमा प्रश्न नं ४ मा जाने)

३.२ यदि छ भने घरको अवस्था कस्तो छ ?

विवरण	किसिम	कैफियत
१. तला	छाप्रो/एक/दुई/तीन/सो भन्दा बढी	
२. छानाको किसिम	स्याउला/खर/स्लेट टायल/टिन वा जस्तापाता/आर.सी.सी.	
३. भित्ताको किसिम	बाँस/माटो ढुंगा/ईटा	
४. घरको अवस्था	नयाँ/पुरानो/भखरै मर्मत गरेको/जिर्ण	

### ४. खानेपानीको अवस्था

४.१ तपाईंको घरपरिवारको खानेपानीको मुख्य स्रोत के हो ?

१. कुवा/मुल      २. सामुदायिक धारा      ३. निजी धारा      ४. इनार/हाते पम्प
५. खोलाभरना      ६. अन्य

५. तपाईंको परिवारको आम्दानीको मुख्य स्रोत के हो ?

१. कृषि      २. नोकरी      ३. ज्यालादारी      ४. रेमिटेन्स      ५. व्यापार व्यवसाय
६. पेन्सन      ७. अन्य

### ६. बैकल्पिक उर्जा सम्बन्धी ज्ञान

६.१ के तपाईंलाई बैकल्पिक उर्जा प्रविधि बारे ज्ञान छ ?

१. छ      २. छैन

६.२ यदि छ भने कुन कुन सेवा बारे थाहा छ ?

१. बायोग्यास                      २. सोलार बत्ती                      ३. सोलार पानी तान्ने पम्प  
४. सोलार ड्रायर                      ५. सोलार कुकर ड्रायर                      ६. सुधारिएको चूलो  
७. माइक्रो हाइड्रो                      ८. अन्य

६.३ कुन माध्यमबाट जानकारी पाउनुभयो ?

१. साथी/नातेदार                      २. रेडियो/टिभि                      ३. छिमेकी                      ४. प्रबर्द्धन केन्द्र  
५. अखबार/बुलेटिन                      ६. अन्य

### ७. चुलोको जानकारी

७.१ तपाईं घरमा कस्तो प्रकारको चुलो प्रयोग गर्नुहुन्छ ?

१. परम्परागत चुलो                      २. सुधारिएको चुलो                      ३. गोबर ग्याँस                      ४. अन्य

७.२ सुचु कसले र कहिले निर्माण गर्नुभयो ?.....

७.३ निर्माण खर्च कति लाग्यो ?.....

७.४ सुचुको मर्मत तथा संभार कसरी गर्नुहुन्छ ?.....

७.५ सुचु प्रयोग गर्नुभन्दा अघि कुन प्रकारको चुलो प्रयोग गर्नु हुन्थ्यो ?.....

७.६ के कस्तो कारणले तपाईं उक्त चुलो उपर सुचुलाई रोज्नुभयो ?

.....

क्र.सं.	प्रश्न	कोड
७.७	पकाउने काम कसले गर्दछ ?	१. आमा                      २. छोरी ३. बुवा                      ४. छोरा ५. अन्य
७.८	कति जना व्यक्तिको लागि खाना पकाउनु हुन्छ ?	१. १- ५                      २. ६- १० ३. १० भन्दा माथि
७.९	सुचु के कामको लागि प्रयोग गर्नुहुन्छ ?	१. बिहानको खाना पकाउन २. बिहान-बेलुकाको खाना पकाउन

		३. अन्य जस्तै: गाई बस्तुलाई कुडो बनाउन
७.१०	कुन प्रकारको भाडा प्रयोग गर्नुहुन्छ ?	१. धातु      २. माटो ३. अन्य
७.११	सुचुमा धुँवा बाहिर पठाउने व्यवस्था छ ?	१. छ      २. छैन
७.१२	यस प्रविधिबाट सन्तुष्ट हुनुहुन्छ ?	१. छ      २. छैन
	यदि छ, भने, सन्तुष्टीको कारण	१. कम धुँवा निस्कनाले २. कम दाउरा खपत ३. आँखा तथा गलामा कम खराब असर ४. कम समयमा खाना पाक्ने ५. भान्सा सफा रहने ६. अन्य
	यदि हुनुहुन्न भने, नहुनुको कारण	१. महँगो २. बढी दाउरा खपत हुने ३. बढी समय लाग्ने ४. अन्य

#### द. तपाईंले घरमा प्रयोग हुने इन्धनको विवरण (प्रति महिना)

विवरण	खाना पकाउन	बस्तुभाउलाई कुँडो पकाउन	बत्ती बाल्न	अन्य प्रयोगको लागि	मूल्य रु. (प्रति यूनिट)
दाउरा (भारी)					
गुईँठा (डोका)					
खेतीबाट प्राप्त हुने*					
मट्टितेल (लिट्र)					
ग्याँस (सिलिण्डर)					
विजुली (यूनिट)					
ब्याट्री					
डिजेल					
अन्य.....					

\*

.....



९. यदि दाउरा प्रयोग गर्ने भए कहाँबाट ल्याउनुहुन्छ ?

१. सरकारी बनबाट कति टाढा पर्छ ? अन्दाजी.....घण्टा

२. सामुदायिक बनबाट कति टाढा पर्छ ? अन्दाजी..... घण्टा

३. निजी बनबाट कति पर्छ ? अन्दाजी..... घण्टा

४. अन्य स्रोत भए उल्लेख गर्नुहोस्

क्र.सं.	प्रश्न	कोड
१०.१	सुचु जडानको आम्दानी स्रोत के हो ?	१. आफ्नो जम्मा पुँजी स्रोत २. बैकबाट कर्जा ३. साहुसँग कर्जा ४. सहकारी वित्तिय संस्था ५. अन्य खुलाउ
१०.२	आफ्नो स्रोतबाट किन्ने पैसा जुटाउन भएको भए कसरी ?	१. पारिवारिक बचत २. रेमिटेन्स ३. सम्पति बेचबिखन ४. ऋण लिएर ५. अन्य
	यदि कर्जा लिएको भए कुन तरिकाबाट चुक्ता गर्नु भयो ?	१. एकै पल्टमा २. पटक पटक गरेर ३. भाका नाघिसकेपछि
१०.३	तपाईंले लिनु भएको सुचु प्रविधिको मुल्य तिर्न गाह्रो लाग्यो ?	१. लाग्यो २. लागेन
१०.४	सुचु किन्दा/जडान गर्दा अनुदान प्राप्त गर्नु भएको छ ?	१. छ २. छैन
	यदि अनुदान प्राप्त गर्न भएको भए कति रकम पाउन भएको थियो ?	रकम रु.....
१०.५	अनुदान कसले दिएको हो ?	१. सरकारले २. एनजिओ (गैससं) ३. अन्य
१०.६	अनुदान दिने प्रक्रिया सन्तोषजनक छ ?	१. छ २. छैन
	यदि सन्तोषजनक छैन भने सुझाव के छ ?	.....

११. सुचुको प्रभाव:

.....

### ११.१ वन जङ्गल तथा वातावरण संरक्षणमा सुधारिएको चुलोको भूमिका

क्र.सं.	फाइदा	प्रभाव		
		अति राम्रो	सामान्य	अप्रभावित
१.	दाउराको खपतमा कमी (२०-५०% सम्म बचत)			
२.	वन विनाश रोक्ने			
३.	जैविक विविधताको संरक्षण र वृद्धि			
४.	हरियाली कायम			
५.	बाढी रोकथाम			
६.	वृक्षारोपणमा खर्च कटौती			
७.	धुँवा कम हुने			
८.	पर्यावरण/वातावरणमा सन्तुलन			
९.	स्वाच्छ, सफा र स्वस्थ वातावरण			

### ११.२ सुचुको मानिसको स्वास्थ्यमा असर:

क्र.सं.	प्रश्न	कोड
१.	तपाईंको विचारमा दाउरा वा घरभित्रको धुँवाले के कस्तो रोग लाग्न सक्दछ ?	१. मुटु सम्बन्धी रोग २. टाउको दुख्ने ३. आँखा पाक्ने ४. मोतिबिन्दु ५. मानसिक रोग ६. अन्य
२.	तपाईंको क्षेत्रमा प्रायजसो लाग्ने रोगहरु के के हुन् ?	१. मुटु सम्बन्धी रोग २. टाउको दुख्ने ३. आँखा पाक्ने ४. मोतिबिन्दु ५. मानसिक रोग ६. अन्य
३.	यी रोगहरु बाट प्राय को पीडित छन् ?	१. महिला २. पुरुष ३. केटी ४. केटा
४.	तपाईंको विचारमा सुचुको जडान पछि तपाईंले उल्लेख गर्नु भएको रोगहरुमा केही परिवर्तन वा सुधार देखिएको छ ?	१. छ २. छैन
५.	यदि छ भने कतिको सुधारको भएको छ ?	१. धेरै राम्रो २. राम्रो ३. ठीकै ४. केही हदसम्म
६.	प्रजनन स्वास्थ्यमा केही कमी भएको छ ?	१. छ २. छैन
७.	यदि छ भने कतिको सुधारको भएको छ ?	१. धेरै राम्रो २. राम्रो ३. ठीकै ४. केही हदसम्म

### ११.३ बालबालिकाको शिक्षामा सुचुको देन

के बालबालिकाको शिक्षामा सुचुले मद्दत गरेको छ ?

१. छ                      २. छैन

यदि छ भने कतिको सुधारको भएको छ ?

क्र.सं.	फाइदाहरु	प्रभाव				
		धेरै असहमत	सहमत	ठीकै	असहमत	धेरै असहमत
१.	आँखामा समस्या नहुनु					
२.	गलामा समस्या नहुनु					
३.	स्वास्थ्यमा परिवर्तन वा सुधार					
४.	पढाईमा सुधार					
५.	पढाईमा प्रोत्साहन					

बालबालिकाको शिक्षामा सुचुले अरु के कस्ता फाइदाहरु पुऱ्याएको छ ?

.....

.....

१२. सुचुले तपाईंको घरमा फाइदाहरु पुऱ्याएकै छ त ?

१. छ                      २. छैन

यदि छ भने के के हुन ?

.....

.....

१३. विभिन्न सुचु हरु गाउँमा टोलमा प्रबर्द्धन गर्न र सुलभ बनाउन के सुभाव दिनहुन्छ?

१.....

२.....

३.....

## ANNEX B: RESEARCH OBJECTIVES

## Research objectives

Research Question	Variables
Effects of Improved Cook Stove on environment and health aspects	<ul style="list-style-type: none"> <li>i. Benefits of ICS on forest and environment conservation</li> <li>ii. Reduction in health problem</li> </ul>
Contribution made by Improved Cook Stove in children education	<ul style="list-style-type: none"> <li>i. No eye irritation</li> <li>ii. No throat infection</li> <li>iii. Improvement in their study</li> <li>iv. Motivation in their study</li> </ul>
User articulation and demonstration on effectiveness of Improved Cook Stove	<ul style="list-style-type: none"> <li>i. Effects of ICS in the community</li> </ul>

The likert scale expressing a range of values for a given answers

1	2	3	4	5
Strongly agree	Agree	Normal	Disagree	Strongly disagree
Better	Good	Fair	To some extent	
Very good	Normal	No effect		

## ANNEX C: DISSERTATION DATA

## Calorific Value of Different Fuel Types

<b>Fuel Type</b>	<b>Calorific Value (kWh/kg)</b>
Firewood	4.16
Kerosene	12
LPG	13.66

## Average Energy Consumption per Month According to HH Activities

<b>Purpose</b>	<b>Energy consumption (GJ)</b>
Cooking	558.04
Lighting	10.25
Cattle feeding	180.01

*Source: Field Survey, 2013*

## Total Energy Consumption in Individual VDC/Municipality

<b>VDC/Municipality</b>	<b>Total Energy Consumption (GJ)</b>
Mangaltar	347.55
Panauti	400.76

*Source: Field Survey, 2013*

## Per Capita Energy Consumption in the Study Area

<b>VDC/Municipality</b>	<b>Per Capita Energy Consumption (GJ)</b>
Mangaltar	0.76
Panauti	0.63

*Source: Field Survey, 2013*

## Conversion Units

VDC/Municipality	Conversion	
	Bhari	kg
Mangaltar	1	20
Panauti	1	20

## Some Calculation of Energy Consumption Per Month in Study Area

Fuel wood	Bhari	kg	Energy Consumption (kWh)
Cooking	10	$10 \times 20 = 200$	$200 \times 4.16 = 832$
Cattle feeding	5	$5 \times 20 = 100$	$100 \times 4.16 = 416$

	Liter	m <sup>3</sup>	Energy Consumption (kWh)
Kerosene	1	$1 \times 0.001 = 0.001$	$12 \times 817.15 \times 0.001 = 9.8$

	Month/LPG	kg/Month	Energy Consumption (kWh)
LPG	3	$14.5/3 = 4.83$	$13.66 \times 4.83 = 66$

Energy Consumption (kWh)	
Electricity	30

## District Energy Consumption 2010/11 (Residential Sector)

Fuel type end use	Unit	Lighting	Cooking	Water boiling	Animal feed cooking	Space heating / cooling	Agro- processing	Appliances	Rituals	Total
Fuelwood	0 kg	0	1,37,052	12,202	25,469	6,311	3,431	0	7,478	1,91,943
Agri residue	0 kg	0	16,792	1,071	18,565	561	173	0	0	37,162
Animal waste	0 kg	0	0	0	0	0	0	0	0	0
Bio gas	0cum	14	41	0	0	0	0	0	0	55
LPG	0kg	0	0	0	0	0	0	0	0	0
Kerosene	KL	1,424	2,288	599	0	0	0	0	201	4,512
Electricity	MWh	4,856	0	0	0	0	0	6,750	42	11,648
Coal/coke	0 kg	0	0	0	0	0	0	0	0	0
Others	GJ	0	0	0	0	0	0	0	0	0
Total	GJ	69,514	25,85,484	2,39,752	6,57,722	1,12,452	59,486	24,300	1.32,126	38,80,836

Source: (District Energy Situation Report, 2013)

## ANNEX D: DISSERTATION DATA REPRESENTATION ON TABLE

Sampling HH Types (For figure 8)

<b>Household Types</b>	<b>Mangaltar VDC</b>		<b>Panauti Municipality</b>	
	<b>Frequency</b>	<b>%</b>	<b>Frequency</b>	<b>%</b>
Residential	155	100	203	98.07
Commercial	0	0	4	1.93
Total	155	100	207	100

Wall Types (For figure 9)

<b>Wall Types</b>	<b>Mangaltar VDC</b>		<b>Panauti Municipality</b>	
	<b>Frequency</b>	<b>%</b>	<b>Frequency</b>	<b>%</b>
Bamboo	1	0.65	0	0
Mud and stone	150	96.77	178	85.99
Brick	4	2.58	29	14.01
Total	155	100	207	100

Contribution of ICS on Children Education (For figure 10)

<b>Contribution of ICS on Children Education</b>	<b>Mangaltar VDC</b>		<b>Panauti Municipality</b>	
	<b>Frequency</b>	<b>%</b>	<b>Frequency</b>	<b>%</b>
Yes	151	97.42	197	95.17
No	4	2.58	10	4.83
Total	155	100	207	100



## ANNEX E: PHOTOS



*Figure 1. Questionnaire Survey in Panauti Municipality*



*Figure 2. Villagers busy with Agricultural Work*



*Figure 3.* Women using ICS for Cooking Purpose in Mangaltar VDC



*Figure 4.* Promoter of Panauti Municipality with Stove Bricks



*Figure 5. TCS in Tamang house in Mangaltar VDC*



*Figure 6. Well Managed Kitchen with ICS*



*Figure 7.* Chimney Outlet of Mud ICS



*Figure 8.* Biogas Plant without Toilet Attachment



*Figure 9. Intake of Feeding Material in Biogas Plant*



*Figure 10. Improved Cook Stove in User's House*



*Figure 11.* Food being cooked in Improved Cook Stove



*Figure 12.* Rocket Stove along with Traditional Cook Stove