CHAPTER: I INTRODUCTION

1.1 Background of the study

Energy, the ability to do work, is essential for meeting basic human needs, extending life expectancy and providing a rising living standard. Energy can be considered in two categories - primary and secondary. Primary energy is energy in the forms of natural resources such as wood, coal, oil, natural gas, natural uranium, wind, hydropower and sunlight. Primary energy can be renewable or non-renewable, Renewable energy sources include solar, wind, wave energy, biomass (wood or crops such as sugar) geothermal energy and hydropower. Non-renewable energy sources include the fossil fuels-coil oil and natural gas. Secondary energy is the more useable forms to which primary energy may be converted such as electricity and petrol. (Pradhan, and Pradhan, 2006:103)

Energy resources may be classified in to three groups: traditional (Biomass), Commercial (conventional) and alternative (renewable) energy. Commercial energy comprises coal, electricity and petroleum products, of which petroleum products and coal are supplied entirely through imports. Biogas, micro hydro, solar thermal, solar voltaic and wind energy are terms as alternative energy sources. The share of alternative energy supply is negligible in the national context. Alternative energy has worthy potential for utilization of rural mountains. Other forms of new and renewable energy technologies include geothermal, hydrogen energy, fuel cell etc. Upon research and development in future, these technologies can be viable options for Nepal. Muscle power may be an important power source in rural Nepal.

Growths in population and economic and social developments, and want for comfort life have put pressure on energy sources in the country. The rate of use of energy source potentials is far less to the demand of energy. With limited availability of alternative energy sources, the traditional sources, up on which the energy output has been based from the very beginning, have received severe pressure. There is increasing gap between supply and demand of energy. This therefore has let the development agencies to adopt technologies to use alternative energy sources that are available in the country. (Pradhan and Pradhan, 2006:168)

Nepal's energy supply is overwhelmingly dependent on biomass resources-fuel wood, agriculture residues and animal wastes. Nepal relies heavily on traditional energy resources, as no significant deposits of fossil fuel are available. Nepalese use the lowest commercial energy (around 500 kWh per capita per year) of all South Asians by far. The total energy consumption in

Nepal for the year 2003/04 was 363 million GJ of which the residential sector consumed 90% and agriculture sector 1%. Based on the fuel type, biomass provided 86% of the total energy consumption, petroleum 9%, which is mainly consumed by urban areas, electricity only 2% and renewable 1% of the total energy consumption (CRT/N, 2005:2)

The prevailing pattern of energy use is unsustainable which has created adverse impacts of the condition of the rural livelihoods. The average annual rate of deforestation is estimated to be 2.1%- a high figure for Nepal's fragile hill ecosystem – against the global average of 0.88%. Depletion of forest cover has put further workload for woman in collecting firewood and fodder and fetching water. On an average, Nepalese woman spend about 12 hours everyday for household chores compared to 9 hours by women in India. Energy has a critical role in the interrelationship among population, development and environment. Population growth creates higher demand for fuel wood, the most accessible energy source. This increased demand puts further pressure on the forest, which is already in a deteriorating condition in Nepal. Desertification, ecological instability, loss of biodiversity, drying up the water springs are some of the serious environmental consequences of massive deforestation. (REDP, 2000: 5)

Most of the energy development efforts have focused on the supply of energy through large-scale hydropower projects for urban areas. These efforts have largely ignored the fact that rural population, for a long time to come, will continue to rely on natural resources for there energy needs. The difficulty of the topographic terrain coupled with scattered settlement is constraints to cost-effective development and provision of energy service in Nepal. Moreover, because of the problems of accessibility as well as affordability, electricity will remain beyond the reach of the rural people. As a consequence, this trend of biomass energy uses will continue to rise unless positive interventions are introduced.

The major energy resource base in Nepal consists of biomass, hydroelectricity, petroleum products, natural gas, and coal reserves. Among the entire energy resource base, it is evident that biomass is the dominant resource base of the country with respect to its utilization. Nepal has a huge potential for hydropower production, but currently this remains mostly untapped. Other commercial forms of energy are not known to exist in any significant amounts.

1.2 Statement of Problem

Rural (renewable) energy can play the role of a catalyst for poverty reduction by providing the modern form of energy. Micro hydro installation both at individual and community levels has contributed to the local economy, institutions building and dissemination of skills and setting industrial enterprises. Renewable energy is clean energy and its uses for cooking and lighting reduce the pollution and health hazards associated with the fuel wood and kerosene.

The importance and the advantages of the rural (renewable) energy on rural development are of many folds. These include:

- Help in reducing the drudgery of rural population.
- Improve the health conditions and living conditions.
- Provide better cooking and lighting environment especially to rural women.
- Save foreign currency by substituting imported fuel.
- Reduce green house gas emissions;
- Have potentials to create rural employment and to increase agricultural productivity
- Contribute towards the sustainable economic development of the country.

There is a dire need to substitute as well as supplement the traditional energy supply system by modern forms of sustainable energy in terms of resources and technology. Because of the country's dependence on imported fossil fuel, high cost of grid connection and low and scattered population density, a decentralized energy supply system becomes the natural and feasible choice. Decentralized new and renewable energy systems such as micro hydro, solar photo voltaic, biogas, improved cooking stove etc provide feasible and environment friendly energy supply options in rural areas.

Attempts to promote rural development to eradicate poverty must include efforts to ensure energy supply in rural area, not an end in itself but as an integral component. Ensuring basic human needs lies at the core of the rural development concerns, and energy services to rural people should be one of the central objectives. However there are the major challenges in Nepal to integrate energy and rural development which are; lack of adequate data on energy requirements & supplies, majority of people still rely on biomass which can’t develop and utilize local resources for the small scale production, distribution and consumption of energy, lack of data availability, lack of organized records, inequitable access to energy resources.

In this context, the present research study has tried to identify the potentiality of energy resources, energy consumption pattern and energy balance in the rural areas. Keeping this in mind, the present study will try to pursuit the following research questions:

- What is the present energy consumption pattern and energy balance in rural area?
- What is the present socio-economic status of rural people?
- What should be done to promote the non-conventional /renewable energy resources?

1.3 Objectives of the study

Since the research study is exploratory in nature, the general objective of the research is to identify the potentiality of energy resources, energy consumption pattern and energy balance in the rural areas. The specific objectives are as follows:

- To know the socio-economic conditions of rural people.
- To find out the present energy use scenario of rural area.
- To evaluate the socio-economic impact of rural energy technologies.

1.4 Hypothesis

In present research study, two hypotheses have been set up and tested statistically using z- test.

Hypothesis: 1

In an average, Nepal's per capita energy consumption is 14.6 GJ per year. The first hypothesis is;

"In the context the rural area of Nepal, per capita energy consumption is less than 14.6 GJ."

Hypothesis: 2

"The annual income of RETs users is greater than the non-users of RETs or Higher the income of the household, there is more possibility to use of RETs."

1.5 Significance of the study

Nepal is a characterized by one of the lowest per capita energy consumption in the world. The energy sector of the country is mainly related to the fuel

wood, agriculture residues, animal dung, petroleum products and renewable energy technologies (RETs).

Energy development is not treated as a multi-dimensional activity in Nepal. It is treated in fragments and in the process, its significance as well as priorities is lost. Energy development with effective linkage with irrigation, water supply, agriculture, forestry or cottage industry is not exploited for holistic development. There does not exist any institutional arrangement, either at the central or at the local levels, to take up energy in its multifaceted –form and as cross-sectional issues. Some of the major issues related to the rural energy of the Nepal are: Inconsistencies in policies for support and implementation of rural energy systems, lack of technical and managerial skills for the operation and maintenance among the rural populace, inadequate information and poor dissemination, lack of adequate data on energy requirements and supplies, ignores the energy needs and problems of the rural population (86%), people's needs are ignored and priorities of the local population is not internalised in the planning and programmes.

So in this present context, the research study is helpful to evaluate the socio-economic impact of rural energy technologies and present energy consumption. This study is also beneficial to policy maker to understand the status of rural populace, their energy needs, priorities and energy balance.

It is also hoped that this study will be helpful to national and international NGOs to planning and implement their program relevant to rural (renewable) energy resources/ technologies.

1.6 Limitation of the study

Nepal's energy scenario is dominated by forestry sector as it supplies more than 80% of the total energy demand. There is suppressed demand of energy and some constraints are general; like as lack of organized records, diverse energy consumption pattern due to the difficulties of geography, culture and economy, difficulties with the physical measurement, large variation in a energy content and rural energy demand are not readily quantifiable.

Researcher being a student does not have so experience of such social research. Researcher is not professional one so might be suffer from some methodological weakness. The following are the limitation of the study.

1. This study has done in particular area. So it can't be universalized.
2. The study has been conducted with in limited time and budget.
3. The study has focused only in Kotdarbar VDC of Tanahun district.
4. The data may different according to the different sources.

5. Finding of the study may not be worth generalizing for the national and international level due to the small area covered by the research.

1.7 Organization of the study

This study has been organized into six chapters. The first chapter describes introduction of the study which includes background of the study, statement of the problem, objectives, significance and limitation of the study.

The second chapter describes literature review related to this study which deals Chapter three presents research methodology including rationale of the selection of the study, sources of data, research design, sampling procedure and instrument of data collection.

The fourth chapter describes the general features of study area. The fifth chapter describes presentation, analysis and interpretation of the related data. The last chapter describes the summary of findings, conclusion and recommendations. After this chapter bibliography and appendices are presented.

CHAPTER: II REVIEW OF LITERATURE

2.1 Energy Consumption Scenario of Nepal

The overall energy consumption of Nepal is largely dominated by the use of traditional non commercial forms of energy such as fuel wood, agricultural residues and animal waste. But this share is in the decreasing trend. The share of traditional forms of energy to the energy consumption is estimated to about 88% in 2004/05 as compared to 91% percent in 1995. The remaining 12% of energy consumed is through commercial source (Petroleum fuels, Coal and Electricity) and Renewable. Table 2.1 shows the historical trend of energy consumption by fuel type and the percentage share for the year 1995 and 2005. It can be seen that though in the slow pace, there is a shift in the energy consumption pattern from traditional to the commercial and renewable sources. The share of commercial has increased from about 9% in 1995 to about 12% in 2005. Similarly there is a growing trend in the renewable. Within the commercial source, electricity is in the higher side in substituting other fuels.

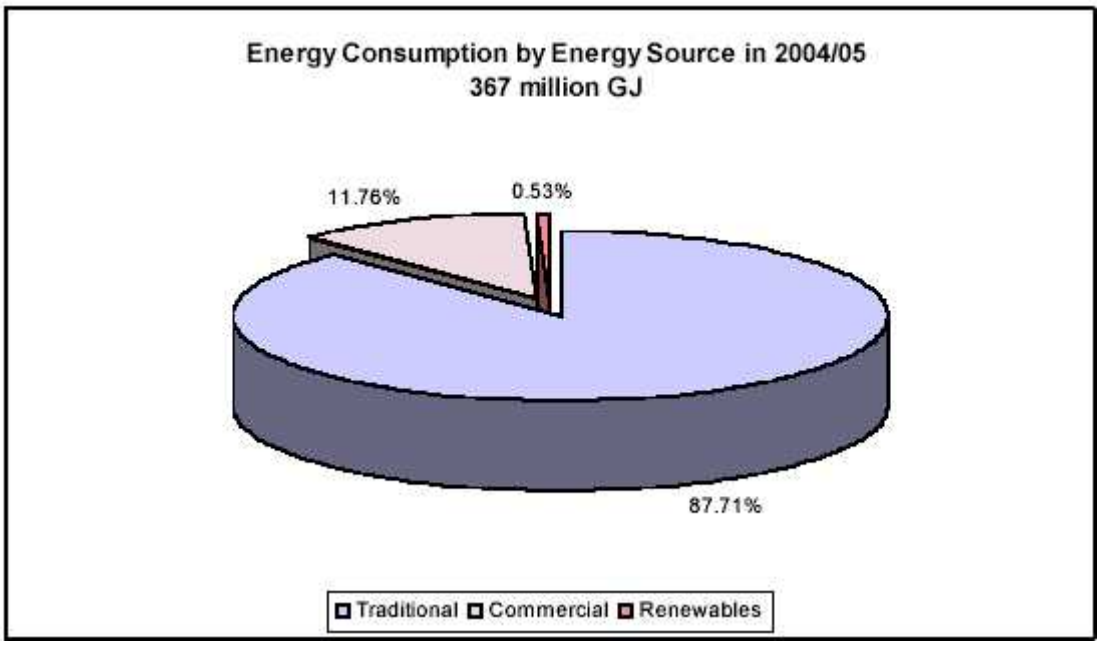
Table No: 2.1 Historical Trend of Energy Consumption by Fuel Type, in 000 GJ

Fueltype	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Share % in 1995	Share % in 2005
Traditional	**258212**	**263634**	**267138**	**272893**	**278748**	**284735**	**290859**	**302085**	**308606**	**315269**	**322105**	**91.14%**	**87.71%**
Fuelwood	230651	235495	237555	242687	247884	253199	258636	269158	274960	280888	286960	81.41%	78.14%
Agricultural residue	10354	10571	11645	11893	12166	12446	12732	13026	13327	13635	13964	3.65%	3.80%
Animal dung	17207	17568	17937	18314	18698	19091	19492	19901	20319	20746	21181	6.07%	5.77%
Commercial	**24784**	**27759**	**29440**	**32741**	**34851**	**44956**	**43344**	**43852**	**43271**	**44863**	**43195**	**8.75%**	**11.76%**
Petroleum	**19119**	**21615**	**23623**	**26619**	**28180**	**30224**	**31286**	**32305**	**32116**	**31596**	**30063**	**6.75%**	**8.19%**
LPG	643	916	1075	1131	1232	1508	1975	2401	2761	3257	3821	0.23%	1.04%
Motor Spirit	1172	1380	1497	1572	1674	1862	1984	2119	2259	2276	2534	0.41%	0.69%
Air Turbine Fuel	1357	1469	1731	1860	2009	2056	2283	1716	1911	2316	2417	0.48%	0.66%
Kerosene	6559	7568	8841	10226	10696	12006	11472	14018	12641	11271	8659	2.32%	2.36%
High Speed Diesel	8597	9501	9783	11402	11978	11780	12367	10857	11378	11369	11911	3.03%	3.24%
Light Diesel Oil	149	174	78	38	21	156	134	94	24	23	3	0.05%	0.00%
Fuel Oil	406	341	320	54	189	428	588	578	554	421	-28	0.14%	-0.01%
Others	236	266	299	337	380	428	482	522	588	663	747	0.08%	0.20%
Coal	**2839**	**3085**	**2540**	**2579**	**2893**	**10504**	**7446**	**6481**	**5721**	**7292**	**6459**	**1.00%**	**1.76%**
Electricity	**2826**	**3059**	**3278**	**3542**	**3778**	**4227**	**4612**	**5066**	**5434**	**5974**	**6673**	**1.00%**	**1.82%**
Renewables	**319**	**435**	**561**	**705**	**856**	**1015**	**1217**	**1432**	**1665**	**1779**	**1955**	**0.11%**	**0.53%**
Biogas	298	412	536	678	826	981	1179	1392	1620	1731	1903	0.11%	0.52%
Micro Hydro	21	23	25	27	30	34	38	40	44	47	50	0.01%	0.01%
Solar	0	0	0	0	0	0	0	0	1	1	2	0.00%	0.00%
Others	0	0	0	0	0	0	0	0	0	0	0	0.00%	0.00%
Grand Total	**283315**	**291827**	**297139**	**306339**	**314454**	**330706**	**335421**	**347369**	**353542**	**361910**	**367255**	**100.00%**	**100.00%**

Source: WECS, 2006.

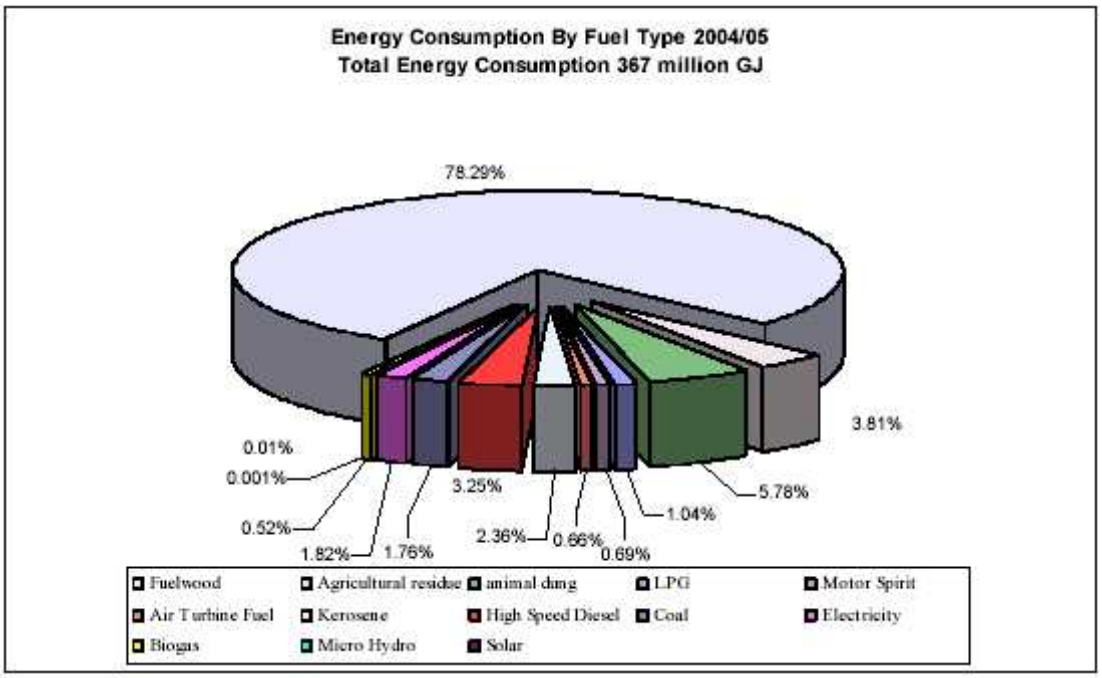
Fig 2.1 and 2.2 indicates the percentage share of fuel source and fuel type respectively in the total energy consumption.

Figure No: 2.1 Energy Consumption by Source Type



Source: WECS, 2006.

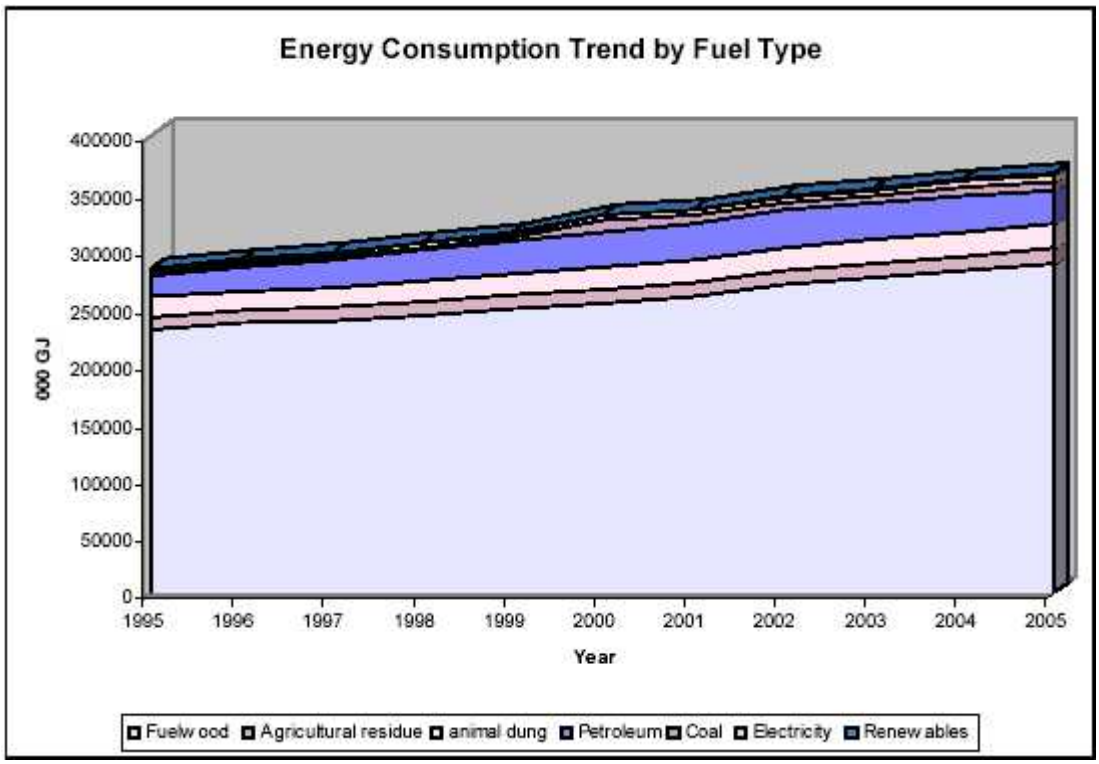
Figure No: 2.2 Energy Consumption by Fuel Type



Source: WECS, 2006.

The consumption of all the fuel types shows continues growth. Compared to the three different sources, it is the commercial source that grew more rapidly compared to other sources. The fig 2.3 shows the different share of fuel types in the total energy consumption since 1995 to 2005.

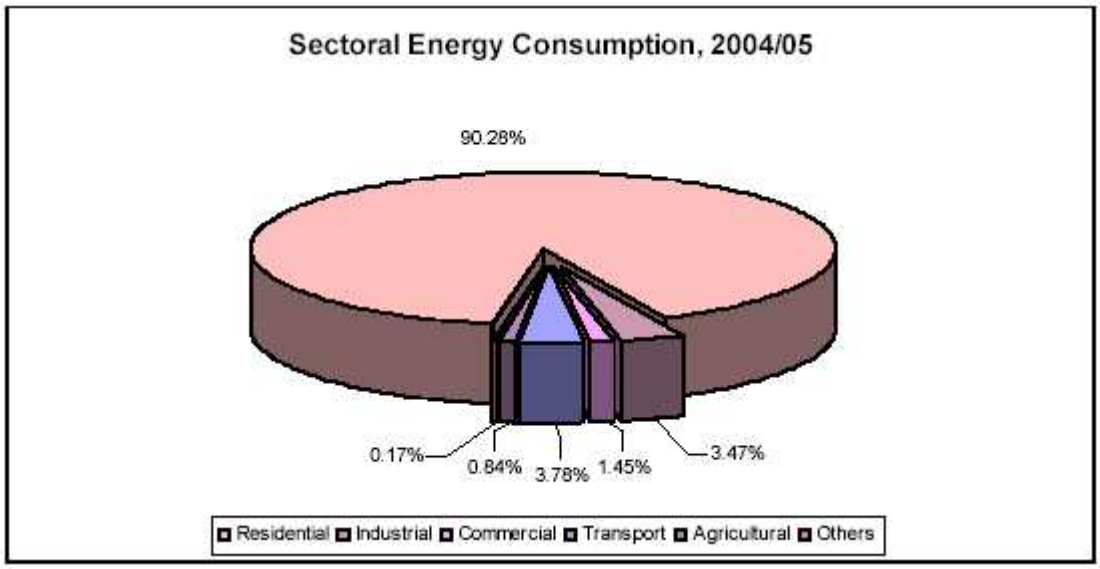
Figure No: 2.3 Energy Consumption Trend by Fuel Type



Source: WECS, 2006.

The energy consuming sectors has been defined as per the economic sector of the country. They are residential, commercial, transport, industrial and agriculture sector. For the ease energy accounting, others have been included as energy consuming entity which does not fall in the above five sectors, are included in others like street light, temples, mosques, church etc.. The sectoral energy consumption pattern for the year 2004/05 has changed only marginally as compared to the previous years. Fig 2.4 shows the different share percentage of energy consumption by various sectors in 2004/05. The figure shows that the residential accounts for the major share of energy consumption (90.28%), followed by transport (3.78%), industry (3.48%), commercial (1.45%) and then the agricultural and others.

Figure No: 2.4 Share of Sectoral Energy Consumption.



Source: WECS, 2006.

2.2 Energy Resource Base in Nepal

The major energy resource base in Nepal consists of biomass, hydroelectricity, petroleum products, natural gas, and coal reserves. Among the entire energy resource base, it is evident that biomass is the dominant resource base of the country with respect to its utilization. Nepal has a huge potential for hydropower production, but currently this remains mostly untapped. Other commercial forms of energy are not known to exist in any significant amounts.

2.2.1 Biomass Energy

Nepal relies heavily on biomass fuel as a result of the lack of development of other energy alternatives and the overall poor economic condition of the nation. Fuel wood is the main source of energy in Nepal and will continue to remain so for a long time. The theoretical estimated sustainable annual yield of fuel wood in Nepal is 25.8 million tonnes, or an average of 2.8 tonnes per hectare of forest. However, only 42 per cent, or 10.8 million tonnes, of the theoretical sustainable supply is accessible.

Forest resources are under increasing threat from the burgeoning human and livestock populations and their need to meet annual requirements for fuel wood, fodder, timber, and other minor forest products. About 44,000 ha of forest area is believed to be degraded and deforested annually, while only about 4,000 hectares are reforested. Conversion of forestland for

cultivation, high population growth, and a low level of development have all aggravated the pressure on forests throughout Nepal. Where forests are becoming relatively scarce, people are relying increasingly on crop residue and animal waste, resulting in the degradation in fertility of the agricultural land. In 1994/95, the supply of crop residues in the country that could be used as energy was estimated to be 112.13 million tonnes (WECS I 994c, PEP 1995). Likewise the country has 4.8 million tonnes of animal dung annually potentially available as fuel.

2.2.2 Hydro power

The hydropower potential of Nepal's river systems is about 83,000 MW, out of which only 25 percent is potentially available for development (WECS 1994; WECS 1996). Hydropower utilization is currently less than one per cent of the proven potential. The total installed hydroelectric generation capacity is 586 MW (NEA 2002). This power has been made available to 878100 consumers through 1962 km of transmission and distribution lines. The national grid represents the overall hydroelectric industry of Nepal as it accounts for almost 98 per cent of the capacity and 99 per cent of the energy supplied. Apart from national grid, both the public and private sectors and independent power producers manage isolated supply systems. At present there are 35 small/mini hydroelectric plants in operation in remote areas of the country.

2.2.3 Fossil Fuel

So far no proven reserves of petroleum suitable for commercial exploitation have been found in Nepal. Thus all petroleum products consumed are imported in refined form for direct consumption. The alternative fossil fuel, natural gas, has also not been discovered as yet in any significant amount. Coal is in many countries among the cheapest sources of energy known. Two deposits are believed to have some economic significance, one in Kathmandu and one in Dang. Even these deposits, however, are believed to be insignificant in terms of the energy demand (WECS 1994).

2.3 Renewable Energy Development Scenario in Nepal

There is a dire need to substitute as well as supplement the traditional energy supply system by modern forms of sustainable energy in terms of resources and technology. Because of the country's dependence on imported fossil fuel, high cost of grid connection and low and scattered population density, a decentralized energy supply system becomes the natural and

feasible choice. Decentralized new and renewable energy systems such as micro hydro, solar photo voltaic, biogas, improved cooking stove etc provide feasible and environment friendly energy supply options in rural areas. The most important renewable energy technology in Nepal is related to Pico hydropower and micro hydropower (up to 100 kW), biomass energy (biogas, briquettes, gasifies, improved cooking stoves), solar photovoltaic (solar home systems, solar PV water pumping, solar battery charging), solar thermal energy (solar water heater, solar dryer, solar cookers etc).

2.4 Energy Acts and Policies in Nepal

The government of Nepal has the sole responsibility for establishing the statutory, legal and policy framework for the energy sector. A number of government departments and agencies are involved in the policy formulation, sub-sectoral planning and project implementation. The statutory framework, under which public and private energy supply activities take place, is embodied in a number of Acts and Regulations approved by the parliament. The main statutes governing energy sector activities at present include:

Forest Act, (1993)
Electricity Act, (1992)
Water Resources Act, (1993)
Hydropower Development Policy, (1992)
Soil & Watershed Conservation Act, 1982
Nepal Petroleum Act, 1983
Nepal Electricity Authority Act, 1984
Mines & Mineral Act, 1985
Industrial Enterprises Act, 1992
Environment Protection Act, 1996
Petroleum Rules, 1984
Solid Waste (Management & Resource Mobilization) Rules, 1989
Water Resources Rules, 1993
Electricity Rules, 1993
Forest Rules, 1994
Buffer Zone Management Rules, 1995
Conservation Area Management Rules, 1996
Environment Protection Rules, 1997

The government of Nepal has also introduced subsidy policy for the development and promotion of renewable energy technology in the name of

Renewable Energy Subsidy Guidelines in 2000 B.S. Micro hydro, Solar, Biogas etc. programs are provided different subsidies through Alternative Energy Promotion Center. Similarly for the development and promotion of Hydropower through private sector, the Government has established Power Development Fund.

2.5 Energy and Environment

The main use of natural resources is to generate energy. Every human action intended for energy generation alters the prevailing environment in one form or the other. There are several ways of analyzing and understanding environmental issues and their policy implications for energy production, supply and use. It was during the early 80s, the government realized that sustainable and maximized economic output of development projects can be achieved by proper due care of environmental aspects. Realizing importance of environment, Government of Nepal has promulgated Environment Protection Act (1996) and Environment Protection Rule 1997 First Amendment 1999. The EPR made compulsion to carry out Initial Environmental Examination/ Environment Impact Assessment and Environmental Auditing for development projects. According to the Act, the proponent must implement environment management plan to minimize the likely impact of the project.

2.6 Renewable Energy Database for Nepal

General

SN	Particulars	Description
1	No. of Rivers	More than 6000 with about total length of 45,000 km
2	Theoretical potential of hydropower	83,000 MW
3	Commercial potential of hydropower	42,000 MW
4	Hydropower so for generated	600 MW (1.4 % of commercial potential)
5	Average sun shine hour/day	6.8 with intensity of solar insolation of about 4.5 kwh/m^2 /day
6	Total energy consumption	8.6 million TOE; about 14.6 GJ per capita per year
7	Share of energy supply	
	Biomass	86%
	Petroleum	9%
	Coal	2%
	Electricity	2%
	Renewable	1%
8	Share of energy consumption	
	Residential	90%
	Industrial	4%
	Transport	4%
	Commercial	1%
	Agricultural	1%
9	Population coverage by electricity supply	
	Central Grid	33%
	Alternative energy	7%

Renewable Energy Technology (installation up to mid 2007)

SN	Particulars	Description
1	Biomass based technologies	
	Improved cook stove	206,000 including national ICS program and other programs.
	Biogas plant installation	172,505 units
	Bee Hive Briqutte Production (Micro enterprise)	50 units
2	Solar bases technologies	
	Solar PV installation	
	For public utilities (aviation, telecommunication, health post etc)	44 units
	Solar Home System	82,674 units
	For water pumping system	40 units
	Solar cookers (Parabolic type)	800 units *(Up to end of 2004)*
	Solar dryer (Box and Cabinet type)	500 units *(Up to end of 2004)*
	Solar water Heaters (Commercial)	35,000 units
3	Hydro based technologies (Decentral)	
	Micro-hydro system (3 to 100 KW)	553 units with about 7805 KW power
	Pico-hydro system (up to 3 kw)	1124 units with about 2019 KW power
	Improved water mills	2719 units (288 long shaft and 2431 short shaft) under IWM support program since Jan 2003 to July 2007 and around 1000 before that.
4	Wind based technologies	
	Installation of wind turbine units	Below 10
	Installation of wind pump units	Below 10

2.7 Organizations related to development of RETs in Nepal.

A numbers of government and semi government agencies, I/NGOs and others private manufacturers / service providers are being involved in the developments of RETs in Nepal.

Government Organizations

- Ministry of Water Resources
- Ministry of Environment, Science and Technology
- Water and Energy Commission secretariat
- National Planning Commission
- Remote Ara Development Committee

Semi-Government Organizations

- Agricultural Development Bank, Nepal (ADB/N)
- Nepal Electricity Authority (NEA)
- Alternative Energy Promotion Centre (AEPC)
- Research Center for Applied Science and Technology (RECAST), Tribhuvan University
- Nepal Academy of Science and Technology (NAST)
- Institute of Engineering / Center for Energy Studies (CES), Tribhuvan University

Non Government Organizations

- Annapurna Conservation Area Project (ACAP)
- Center for Rural Technology, Nepal (CRT/N)
- Nepal Biogas Promotion Group
- Center for Renewable Energy (CRE)
- Center for Self-help Development (CSD)
- Biogas Sector Partnership, Nepal (BSP-Nepal)
- Association of Micro-Hydro Manufactures
- Associations of Solar Energy Manufactures

International Non-Government Organizations

- Practical Action Nepal
- Integrated Center for Mountain Development (ICIMOD)
- United Mission to Nepal (UMN)
- Energy Sector Assistance Program (ESAP), Embassy of Denmark (Kathmandu)

- Rural Energy Development Program (REDP), UNDP
- German Technical Cooperation Agency (GTZ)

Private Companies

- Micro- hydro related consultants and Installation Company.
- Biogas Companies.
- Solar companies.

CHAPTER: III RESEARCH METHODOLOGY

3.1 Rational of the selection of study Area:

Energy situation of Nepal is characterized by diverse energy consumption pattern due to the differences in geographical, socio-cultural and economical situation. The majority of rural households live in poverty with the minimum level of energy consumption. This implies the high level of price and income inelasticity of energy. Nepal's energy scenario is dominated by forestry sector as it supplies more than 80% of total energy demand. This demand has further pressure on forest, which is already in deteriorating condition in Nepal. Desertification, ecological instability, loss of bio-diversity, drying up water springs are some of the serious environmental consequences of massive deforestation.

On the other hand, renewable energy technologies have not been massively disseminated Nepal as compared to their technical potentialities and should not be done proper assessment of energy resources to meet the energy needs of rural people. There is the lack of the adequate data on energy requirements and supply, which causes the negative effects of the program implementation. People's needs are ignored and priorities of the local population are not internalized in the planning and programs. So, the above justifications are the main reason of the selection of study.

To conduct this study, kotdurbar VDC of Tanahun district have been selected as the study area. Kotdarbar VDC has 975 households and 6346 population where different caste/ethnic groups are residing mainly Magars and dalits. In kotdarbar VDC, Rural Energy Development Program (REDP) have been implementing since 1996.The principle aim of REDP is to enhance the rural livelihood through the promotion of decentralized Rural Energy Technologies (RETs), specially community managed micro hydro projects. Kotdarbar VDC has sound socio-economic status, accessibility, faithful community, minor knowledge about renewable energy technologies. So, this VDC have been chosen as a study area.

3.2 Study Methodology

In order to complete the research study, the following methodologies has been adopted:

- Desk Study.
- Household Survey.
- Primary Data Collection.

- Secondary Data Collection.
- Participatory Rural Appraisal.

3.3 Nature and Source of Data

The nature of the data in the study is both quantitative and qualitative. Similarly, the study is utilized both primary and secondary sources of data. A primary source of data is generated from field survey and Participatory Rural Appraisal (PRA). Secondary data is collected from related books, reports, journals, published and unpublished dissertation, websites etc relevant to topic.

3.4 Research Design

The present research is mainly tried to identify the potentiality of energy resources, energy consumption pattern and energy balance in the rural areas and also try to find out the present energy use scenario of rural area. Being a social in nature, an exploratory as well as descriptive research design has been applied.

3.5 Sampling Procedure

Kotdarbar VDC (study area) has 975 households and 6346 population according to CBS, 2001. However, in order to finalize the household number and head of household, sample size was determined using the household list from the updated data (in 2063 B.S.) provided by District Election Office, Tahanun. According to this data, firstly sample size (no. of households) was determined using the formulae and secondly probability proportional sampling (PPP sampling) method adopted to finalized the sample size based on wards. Finally Simple random sampling procedure was carried out to finalize the sample HH.

Sampling Procedure:

1. Total no. of households according to District Election Office, Tanahun is 833.
2. Sample size was determined by using the formulae (assuming 95% confidence level and 5 % error)

$$n = m / (1 + m/N)$$

Where $m = Z^2 * pq / d^2 = (1.96)^2 * 0.5 * 0.5 / (0.05)^2 = 0.9604 / .0025 = 384.16$

N = Total sample population (i.e. total HHs) = 833

Using above formula,
Sample size (n) = 262.91 = **260** *(In round figure)*

Table No: 3.1 Probability proportional sampling

Ward No	Total no. of HH	PPS sample size	Sample size in round figure
1	132	41.20	41
2	89	27.78	28
3	62	19.35	19
4	101	31.52	32
5	70	21.85	22
6	116	36.21	36
7	87	27.15	27
8	95	29.65	30
9	81	25.28	25
Total	833	260.00	260

Out of 260 samples HHs, there were 149 HHs from RETs users and 111 HHs from non users of RETs.

3.6 Instrument of data collection

This study has been based on household survey through the structured checklist, key informant interview, in-depth interview based on the questionnaire. Participatory rural appraisal is also used as instruments of primary data collection.
The relevant secondary data and information were collected from related books, reports, journals, published and unpublished dissertation, websites etc relevant to topic.

3.7 Methods of Analysis and Presentation:

The data collected through various instruments and sources were descriptively analyzed and presented. Simple statistical tools such as numbers, percentage, average and ratio will be used to interpret the findings. Similarly the collected data is presented using tables, charts and diagrams so that the report will be simple and understandable to the readers and the result was interpreted dividing into different headings and sub-headings as per the nature of data.

CHAPTER: IV GENERAL FEATURE OF THE STUDY AREA

4.1 A brief introduction of Tanahun district.

Tanahun district is one of the hilly district of Nepal. This district situated 27 3' to 28 5' north latitude and 83 75' to 84 34' east longitude having total area 1546 sq. km. The attitude of the district is between 240 m to 2325 m from the sea level. Tanahun district is surrounded by Chitwan and Gorkha district in east, Syangja district in west, Kaski and Lamjung district in north and Palpa, Chitwan and Nawalparasi districts to the south. The total population of the district is 315,237 numbers, out of this 168,449 (53.4%) are female. Magar, Brahmin, Gurung, Chhetri, Newar, Kami, Damai are the major caste of the district. Literacy rate of above 6 years age in Tanahun district is 71.27% where male literacy is 80.9% and female literacy is 62.8%. (DDC, Tanahun: 2007)

4.2 Geographical and demographical characteristic of study area.

Kotdarbar VDC is surrounded by Kahunshivapur VDC in east, Risingranipokhari and Ramjakot VDC in west, Jamune VDC in north and Virkot VDC to the south. This VDC is situated 27 88' to 27 96' north latitude and 84 15' to 84 23' east longitude having total area 43.98 sq. km. The attitude of the district is between 320 m to 1233 m from the sea level.

4.3 Population by age group of Kotdarbar VDC

The kotdarbar VDC has 975 households with the total population 6346 among them 2850 are male and 3496 are female. (CBS: 2001)

Table No: 4.1 Population by age group of Kotdarbar VDC

SN	Age group	Male	Female	Total	Total Percent
1	0 - 4	385	420	805	12.69
2	4 - 9	483	480	963	15.17
3	10-14	450	447	897	14.13
4	15-19	287	415	702	11.06
5	20-24	166	332	498	7.85
6	25-29	108	279	387	6.10
7	30-34	134	164	298	4.70
8	35-39	129	157	286	4.51
9	40-44	122	162	284	4.48
10	45-49	146	137	283	4.46
11	50-54	101	136	237	3.73
12	55-59	95	93	188	2.96
13	60-64	83	84	167	2.63
14	65-69	57	59	116	1.83
15	70-74	48	57	105	1.65
16	75 & More	56	74	130	2.05
Total		2850	3496	6346	100

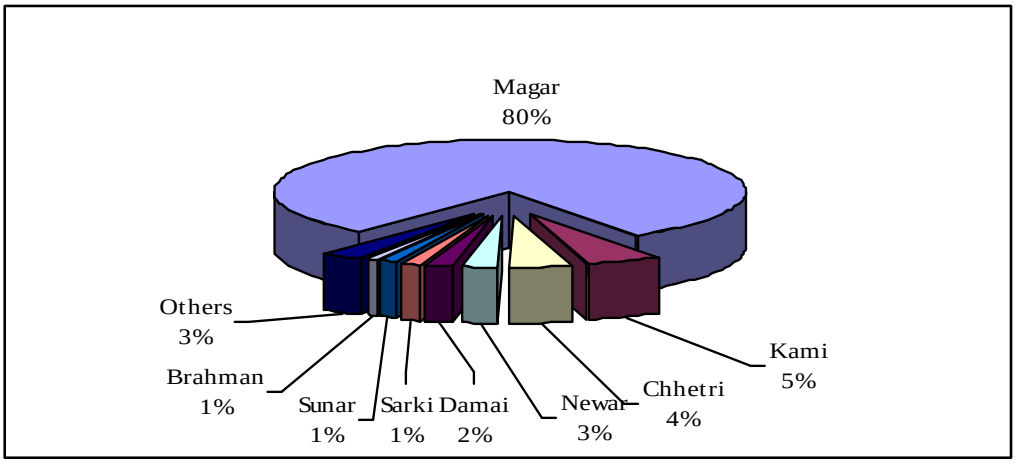
Source: CBS, 2001.

Table No. 4.1 shows that there were 50.51 % population is less than 15 years and over 60 years of age, which is dependence population. This type of dependence population has negative impact for development activities.

4.4 Population composition by caste and ethnicity

In the study area, Kotdarbar VDC out of total population 80 % population is Magar.

Figure No: 4.1 Population compositions by caste and ethnicity



Source: CBS, 2001

4.5 Literacy status over 6 years of age

In kotdarbar VDC, 52.89% of the people over six years age are illiterate. In the study area literacy rate is low which has negative implication for development and knowledge of proper energy uses.

Table No: 4.2 Literacy status over 6 years of age

S.N.	Literacy status	Population					
		Male	Percent	Female	Percent	Total	Percent
1	Can't read and write	941	38.66	1887	64.78	2828	52.89
2	Can read only	123	5.05	86	2.95	209	3.91
3	Can read and write	1370	56.29	940	32.27	2310	43.20
Total		**2434**	**100.00**	**2913**	**100.00**	**5347**	**100.00**

Source: CBS, 2001

4.6 Economic characteristics of study area

4.6.1 Poverty and Human development

The per capita income of Kotdarbar VDC is NRs. 35,846/- . The highest per capita income of the Tanahun district is in Chhang VDC i.e. NRs. 60,315/- and Lowest in Jamune VDC i.e. NRs 948/-. (DDC, Tanahun: 2001)

In this VDC, about 63% households lie below poverty line. (According to the poverty measurement index determined by NPC i.e. NRs. 30,000 annual income of per HH). Likewise about 78% of households lie below poverty line. (According to the poverty measurement index determined by World Bank i.e. NRs. 50,000 annual income of per HH). The HDI of the VDC is 0.5080 which lies 25th position of the total VDC. (DDC,Tanahun: 2001)

Majority of houses lies below poverty line. Poverty is the main challenges of the developing countries like Nepal. There is inverse relationship between poverty and energy consumption.

4.6.2 Major sources of income

The major source of income in Kotdarbar VDC is agricultural (both crops and livestock). However, the income from the job, business, foreign job/pension and labour is also noticeable in this VDC.

4.7 Access to Energy

Biomass is the main sources of energy in Kotdarbar VDC. Fuel wood is mainly collected from government forest and community forest. There is easily access to collect fuel wood except some hamlet. For lighting about half of the total households are using electricity from MHP. In kotdarbar VDC, Rural Energy Development Program (REDP) have been implementing since 1996.The principle aim of REDP is to enhance the rural livelihood through the promotion of decentralized Rural Energy Technologies (RETs), specially community managed micro hydro projects. REDP has successfully commissioned three MHPs in Kotdarbar VDC. Small percentage of population is using Biogas as energy for cooking.

CHAPTER: V DATA ANALYSIS AND INTERPRETATION

5.1 Socio-economic status of the people of Kotdarbar VDC

The supply, demand and consumption of rural energy is directly or indirectly influenced by the socio-economic factors. Therefore in this section, the information of demographic, social as well as economical indicators has been presented and analyzed.

5.1.1 Household size:

There is directly relationship between energy supply and consumption with family size. If there is large number of family, the consumption and supply is also high and vice-versa.

Table No: 5.1 Household Sizes of Respondent HHs

SN	Household size	No. of Respondents	Percent
1	1 to 3	25	9.62
2	4 to 6	90	34.62
3	7 to 9	71	27.31
4	10 to 12	44	16.92
5	12 to 15	19	7.31
6	16 & above	11	4.23
Total		**260**	**100.00**

Source: Field Survey, 2008

From the table no. 5.1, it is cleared that 34.62% households have 4 to 6 numbers of family members. Similarly, 27.31% households have 7 to 9 numbers of family members. The Family size among 1 to 3 is only 9.62%.
The average family size of the sample HHs is 7.8, this data is greater than the CBS figures (i.e. average family size is 5.89)

5.1.2 Caste and Ethnicity Composition

According to the PRA, ward wise composition of caste and ethnicity in kotdarbar VDC is presented below.

Table No: 5.2 Ward wise Cast and Ethnicity Composition in Kotdarbar

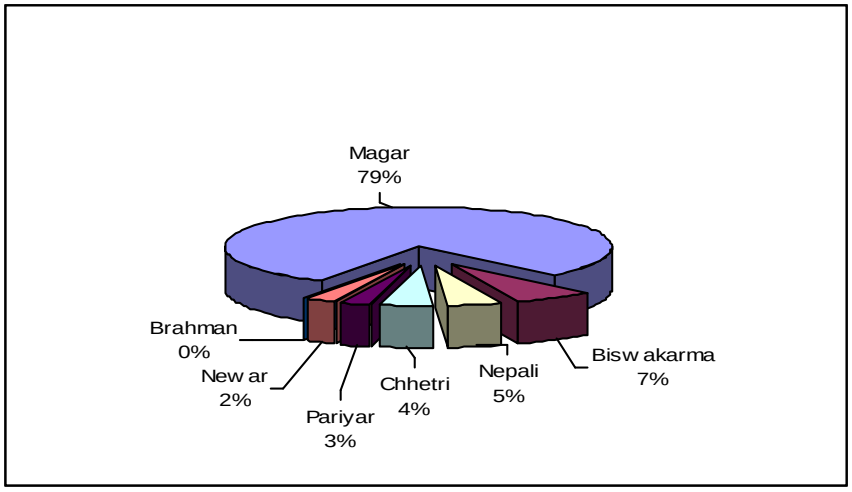
Ward No	Total HH	Cast						
		Magar	Kami	Damai	Sarki	Newar	Brahman	Chhetri
1	169	167	0	2	0	0	0	0
2	111	107	4	0	0	0	0	0
3	85	57	22	5	0	0	1	0
4	137	119	0	1	16	1	0	0
5	63	2	20	17	0	24	0	0
6	128	115	0	0	9	0	0	4
7	102	102	0	0	0	0	0	0
8	128	74	7	2	9	0	0	36
9	118	80	21	0	13	0	0	4
Total	**1041**	**823**	**74**	**27**	**47**	**25**	**1**	**44**
Percentage	**100**	**79.06**	**7.11**	**2.59**	**4.51**	**2.40**	**0.10**	**4.23**

Source: PRA, 2008.

Kotdarbar VDC is the one of the VDC of Tanahun district where large numver of Magars are residing. According to table no. 5.2 , out of the 1041 HHs, amongs are Magars (79.06%). Magar, the main janajati of Nepal, have there own culture and tradition. They makes traditional wine (Raksi), consuming more amount of fuel wood. Dalits are the second highest population in terms of cast and ethnicity groups in Kotdarbar VDC.

There is less population of Newar, Chhetri and Brahman. The following figure shows the percentage of cast and ethnicity in Kotdarbar VDC.

Figure No: 5.1 Caste and ethnicity composition in Kotdarbar VDC

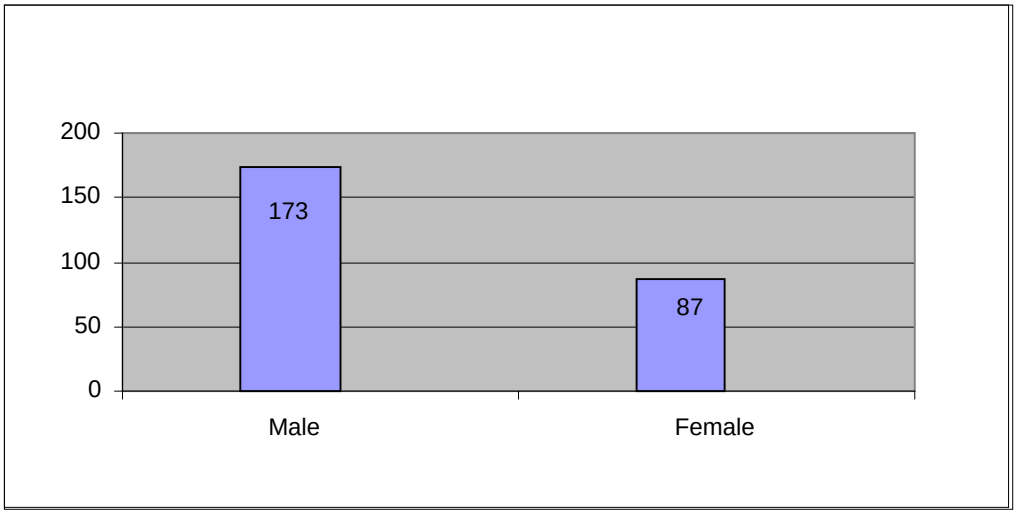


Source: PRA , 2008.

5.1.3 Gender Composition of the Respondents

The survey included 260 respondents both respondents, both male and female. Out of 260 respondents, 173 are male and only 87 are female. Generally the head of the household is male. So, the numbers of male respondent are higher than female respondent. The gender composition is presented in figure no.5.2.

Figure No: 5.2 Gender Compositions of the Respondents

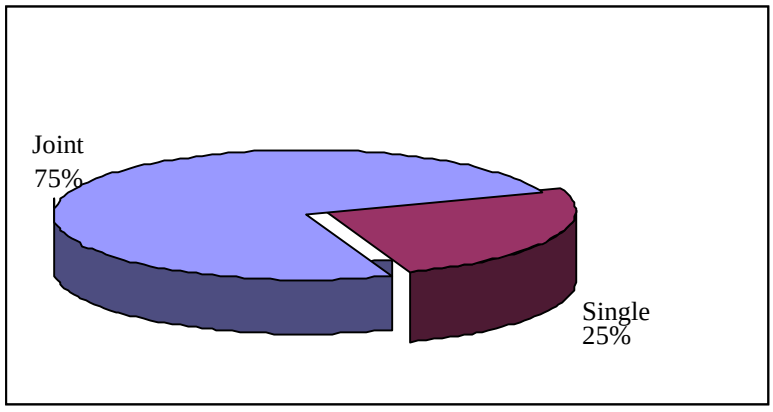


Source: Field Survey, 2008.

5.1.4 Family Type of Respondents

There are major two types of family in Nepal: namely, joint and single. Single family has less number of family members where as joint family has more members. There is a strong relationship between family type and energy consumption pattern. In joint family, the consumption and supply of energy is higher than single family.

Figure No: 5.3 Family Type of Respondents



Source: Field Survey, 2008

5.1.5 Education Status of the sampling Population

Education is taken one of the main social indicators of development. Education is also helps to people for better living. It is generally accepted that the educated people are more active, articulated & understandable in different issues and more involvement in development activities than the uneducated population. Education is also talen one of the important and essential elements for development of any society. Education helps to people to know about the energy resources, conservation and efficient uses of energy resources and promotion of renewable energy technologies. The ward wise literacy rate of sampling population is presented in table no. 5.3.

Table No: 5.3 Ward wise Literacy of Respondent's Population

SN	Ward No.	No. of Respondent	Literate		Total		Literacy Percentage	
			Male	Female	Male	Female	Male	Female
1	1	41	122	99	159	184	77	54
2	2	28	99	82	121	127	82	65
3	3	19	65	46	77	75	84	61
4	4	32	97	85	132	108	73	79
5	5	22	69	66	74	84	93	79
6	6	36	132	105	152	146	87	72
7	7	27	88	76	118	110	75	69
8	8	30	80	68	99	102	81	67
9	9	25	64	53	77	73	83	73
Total		**260**	**816**	**680**	**1009**	**1009**	**81**	**67**

Source: Field Survey, 2008.

According to the table no.5.3, out of total 2018 no. of population, 81% male are literate where as 67% female are literate. Comparatively, the literacy rate of female is low. There is clearly observed the inequality in literacy status of male and female. In an average, the total literacy rate is 74%.

5.1.6 Occupation

Occupation is one of the important indicators of the economic status of the people. It also determined the household wealth, well-being and social stigma in society. Occupation plays a vital role of energy consumption pattern. If the peoples were jobholder or a businessman, they used the modern sources of energy like as LPG gas, solar electricity, Bio-gas etc. The table no. 5.4 shows the main occupation of the respondents.

Table No: 5.4 Major Occupation of the Respondents

SN	Occupation	No. of Respondent	Percent
1	Agriculture	251	96.54
2	National Job	2	0.77
3	Foreign job	7	2.69
Total		**260**	**100.00**

Source: Field Survey, 2008.

Most of the respondents are involved in agriculture. Out of 260 respondents 251 (96.54%) are dependent to agriculture for their livelihood. Only 7 respondents stated the foreign job/ pension as their occupation and only two respondents stated that job is their occupation. So, the major occupation of respondents was found agriculture.

5.1.7 Land holding Pattern and Types of Land Use.

Land is also an important indicator of economic status of the people. Land holding pattern plays a significant for the supply of the rural energy resources. People use their own land to collect the fuel wood, agriculture residue and other biomass resources.

Type of land is also important for the collection of the energy resources. Khet, Bari, Buttyan and plantation area have their own features. People also can use their own plantation land, private forest to collect the biomass resources.

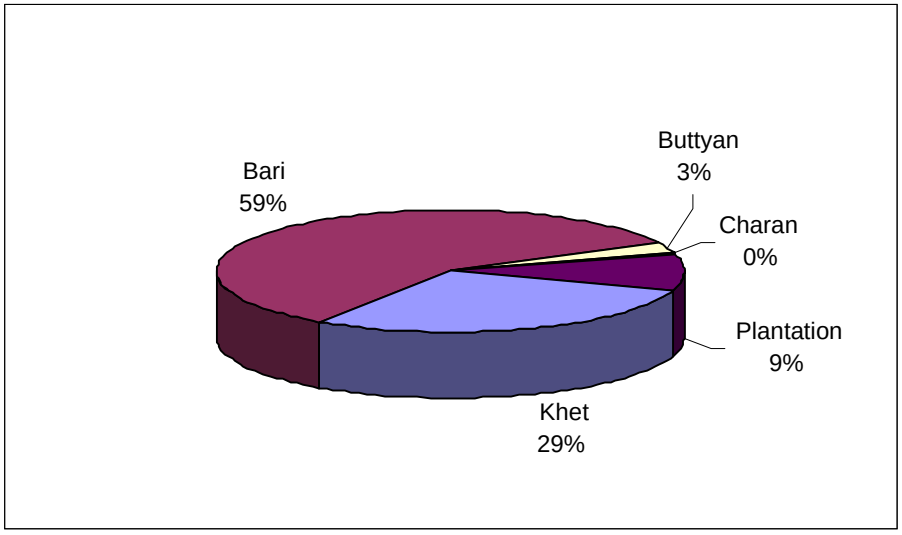
Table No: 5.5 Land Holding Size of the Respondents

SN	Land Size	No. of respondent	Percent
1	1 to 5 ropani	100	38.46
2	6 to 10 ropani	65	25.00
3	11 to 15 ropani	54	20.77
4	16 to 20 ropani	17	6.54
5	21 and above	24	9.23
Total		**260**	**100**

Source: Field Survey, 2008.

Table no. 5.5 shows that the most of the respondents (38.46%) have only 1 to 5 ropanies of land. 25% respondents have 6 to 10 ropani of land, 20.77 % have 11 to 15 ropani, 6.54% have 16 to 20 ropani and 9.23 % have 21 and above respectively.

Figure No: 5.4 Land Use Pattern of the respondents



According to the figure no.5.4, most of the land (59%) have been using as Bari (Non irrigated land) which indicates there is no proper irrigation system of land. Similarly, the figure shows that 29% of lands have been using as Khet (Irrigated land), 9 % of lands have been using as a plantation, 3% of land have been using as a Buttyan.

5.1.8 Livestock of Respondent's Family

Livestock is also a kind of property and it is also an important indicator of the economic status of rural area of Nepal. Energy supply, consumption and potential is depends upon the total number of different kind of animals. If there is more number of cow and buffaloes, there is more chances to construct the biogas plants. The people, who have the large number of livestock, need the larger scale of fuel wood for livestock rearing. The energy consumption is also higher due to the large number of livestock.

Table No: 5.6 Livestock Holding of Respondents

SN	No. of Livestock	No. of Respondent	Percent
1	1 to 10	64	24.62
2	11 to 20	87	33.46
3	21 to 30	66	25.38
4	31 to 40	30	11.54
5	41 to 50	9	3.46
6	51 and above	4	1.54
Total		**260**	**100.00**

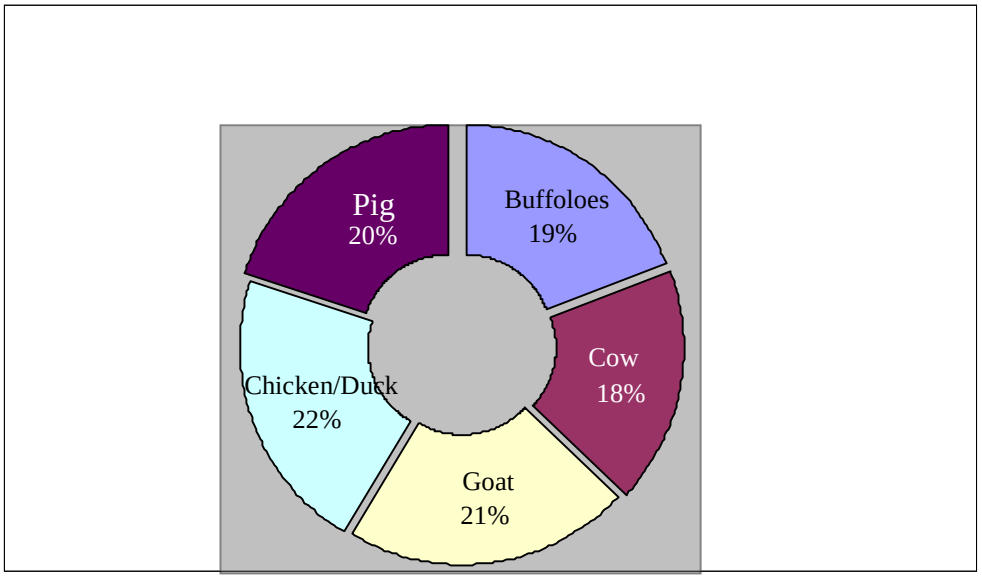
Source: Field Survey, 2008.

Table no. 5.6 shows that 33.46% of total respondents have 11 to 20 no. of livestock including Buffalo, Cow, Goat, Chicken/Duck and Pigs. Similarly, 24.62% have 1 to 10 numbers, 25.38% have 21-30 numbers, and 11.34% have

31-40 numbers of livestock. There is less no. of livestock above 40. From the above table, it is cleared that almost of the family have livestock rearing in study area.

The figure no. 5.5 shows that total percentage of livestock in to the respondent households.

Figure No: 5.5 Animal Husbandry of the respondents



Source: Field Survey, 2008.

From the figure no. 5.5, it is summarized that there is almost equal numbers of the livestock in study area.

5.1.9 Food Sufficiency from Agriculture Production

Food sufficiency is one of the major indicators of economic status of the households. Higher the month of the food sufficiency, better would be the economic condition of the family. Such a family can afford the cost of the innovative technologies life as solar photo voltaic, bio-gas etc. If there is food sufficiency from there own agriculture land, there is higher chances to use of modern technology. Based on PRA, the word wise food sufficiency from agriculture production is presented in table no 5.7.

Table No: 5.7 Food Sufficiency Status in Kotdarbar VDC

SN	Food sufficiency	Ward Numbers									Total HHs	Total Percent
		1	2	3	4	5	6	7	8	9		
1	Up to 12 month	17	15	3	5	5	10	6	10	6	77	**7.40**
2	Up to 9 month	74	52	50	14	10	50	25	35	25	335	**32.18**
3	Up to 6 month	56	26	20	98	20	50	40	56	58	424	**40.73**
4	up to 3 month	22	18	12	20	28	18	31	27	29	205	**19.69**
Total		**169**	**111**	**85**	**137**	**63**	**128**	**102**	**128**	**118**	**1041**	**100.00**

Source: PRA, 2008.

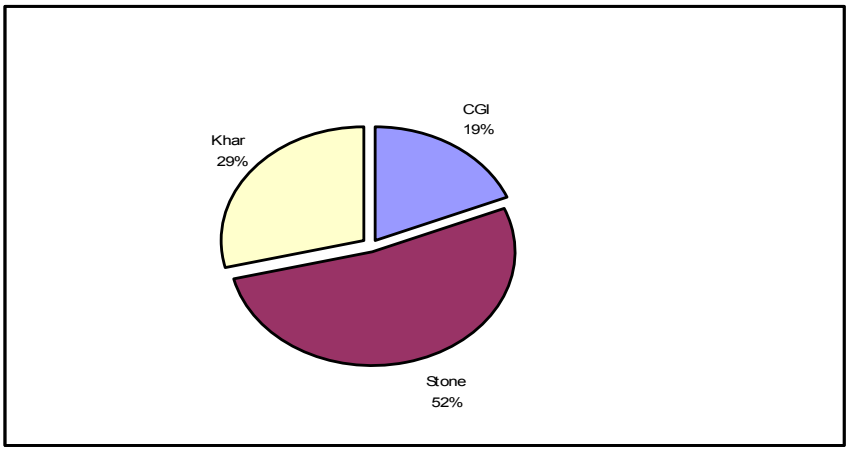
According to the table no. 5.7, out of total 1041 HHs in Kotdarbar VDC, 205 HHs (19.69%) household have the worst condition and they have food insufficiency. Similarly, 424 HHs (40.73%) have food sufficient up to 6 months from their own agriculture production, 335 HHs (32.18%) have food sufficiency for 9 months. There is only 77 HHs (7.4%) have food sufficient for whole year.

Above description indicates that majority of households have facing the problem for food and they have to manage other way to survival. From this situation, we can conclude that there is a challenge to promote the RETs like as Solar PV, Solar dryer, and Bio-gas etc.

5.1.10 Roof Type of House in Kotdarbar VDC

Roof type is also the indicator of economic status of the rural household in Nepal. It can also be used for determination of poverty. Generally, CGI roofing has indicates the strong economic condition and Khar (a kind of local grass) roofing has indicates the lower economic condition.

Figure No: 5.6 Roof Type in Kotdarber VDC.



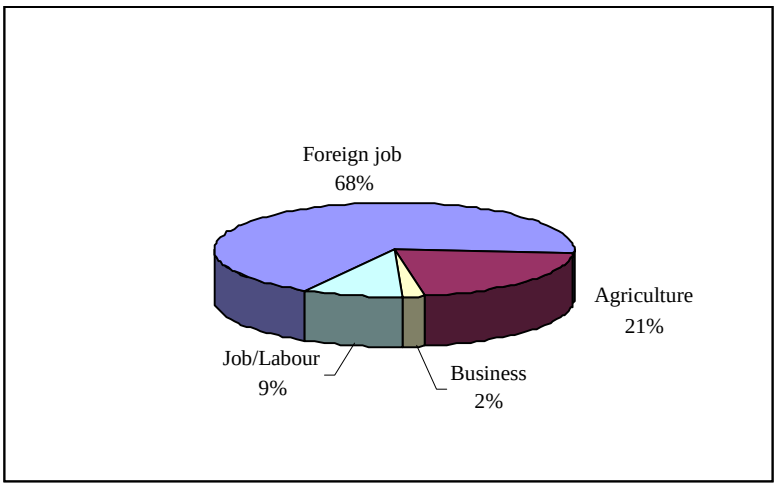
Source: PRA, 2008.

According to the figure no.5.6, in kotdarbar VDC, there is 52% household have stone roof, 29% household have khar roof and 19% household have CGI roof.

5.1.11 Major Sources of Income of Respondents

Generally, the main source of income is depending up on the people's major occupation. In the context of rural economy of Nepal, agriculture is regarded as one of the important sources of income. However, due to the less productivity and disguised unemployment in agriculture sector, the young generation is going to the foreign countries for searching the job. Figure no. 5.7 shows the major income sources of respondents in study area.

Figure No: 5.7 Major sources of Income of Respondent HH Family



Source: Field Survey, 2008.

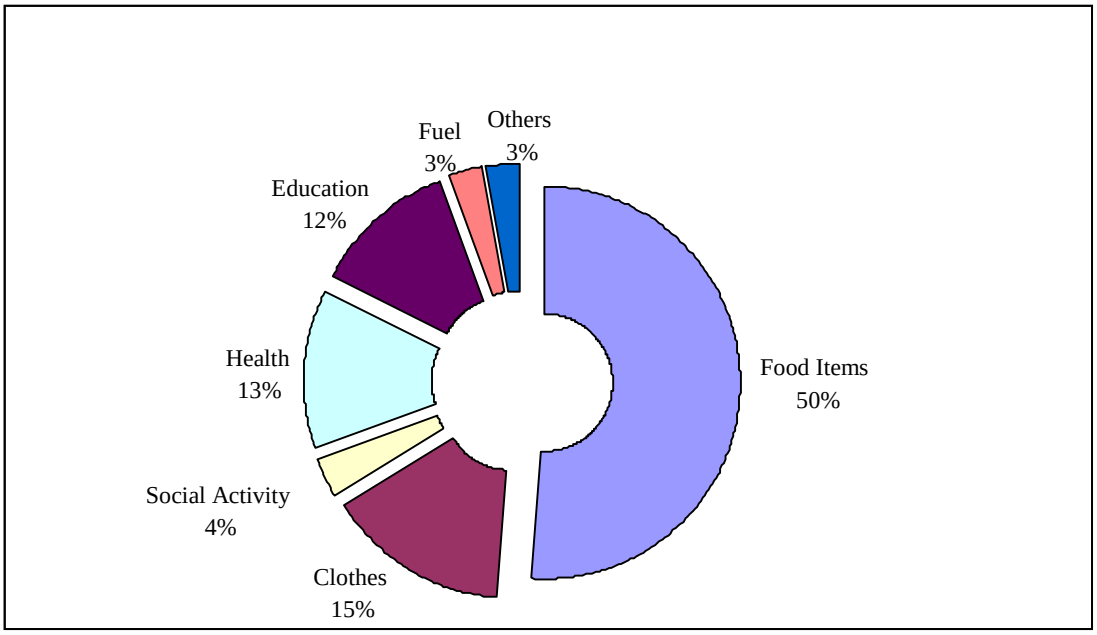
Figure no. 5.7 shows that foreign job is the main sources of income in to the sampling households. 68 % income is earned from foreign countries. Similarly, agriculture (21%) is the second main income sources. Agriculture

sources include the income from agriculture production, animal rearing and vegetables production. Similarly, 9 % income earned from job in home country and labour. Only 2% income earned from business.

5.1.12 Total Expenditure of Respondents in Different Heading

Human beings have unlimited necessaries/needs. Due to the low-income status in developing countries like Nepal, almost of the income have to used for fulfilling their basic human needs (Food, Shelter, Clothes). Figure no 5.8 shows the expenditure in different heading of the respondents HHs.

Figure No: 5.8 Total Expenditure of Respondents in Different Heading



From the figure no. 5.8, we have comes to know that 50% of total income is expanses in food. Similarly, out of total expenses, 15% expenditure in clothes, 13 % in health, 12% in education, 4 % in social activity, 3% in fuel and 3% in others respectively. According to above data, 78% of total expenses used to fulfilling the basic needs of human beings.

5.2 Supply and Consumption pattern of Energy Resources:

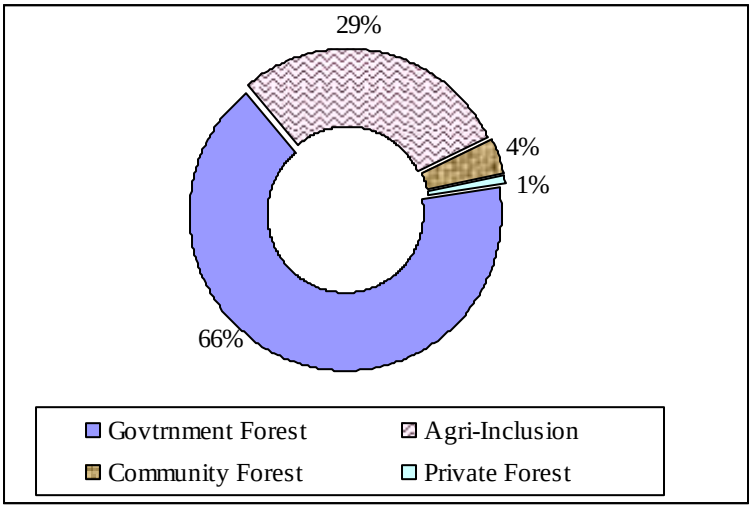
Nepal's energy supply is overwhelming depends up on the biomass energy resources such as fuel wood, agriculture residue and animal dung. Biomass provided 86% of the total energy consumption, petroleum 9% which is mainly consumed by urban areas, electricity 2% and renewable 1% of total energy consumption. Among the resources, fuel wood consumption has increased rapidly which means that the forests are depleting. In the context of rural areas most of the energy consumption from fuel wood. Yet, fuel wood is the cheapest form of the energy in rural Nepal.

In this section, energy supply and consumption pattern has been presented.

5.2.1 Major Sources of Fuel Wood Supply:

Fuel wood is the major energy sources of rural Nepal. Fuel wood can be collected from different sources like, government forest, agro inclusion, community forest, private forest etc. The fuel wood supply by sources is presented in figure no 5.9.

Figure No: 5.9 Sources of Fuel Wood Supply by Respondent HH



Source: Field Survey, 2008.

According to the figure no 5.9, government forest is the main sources of fuel wood supply. 66% of total fuel wood has been collected from government forest, which means there is more pressure in government forest. Similarly 29% fuel wood has collected from agro inclusion, 4% from community forest and 1% from private forest.

5.2.2 Energy Supply by Respondent HHs

The main energy sources are fuel wood, agriculture residue, Petroleum products and renewable energy. The following table shows the total energy supply by respondent per year.

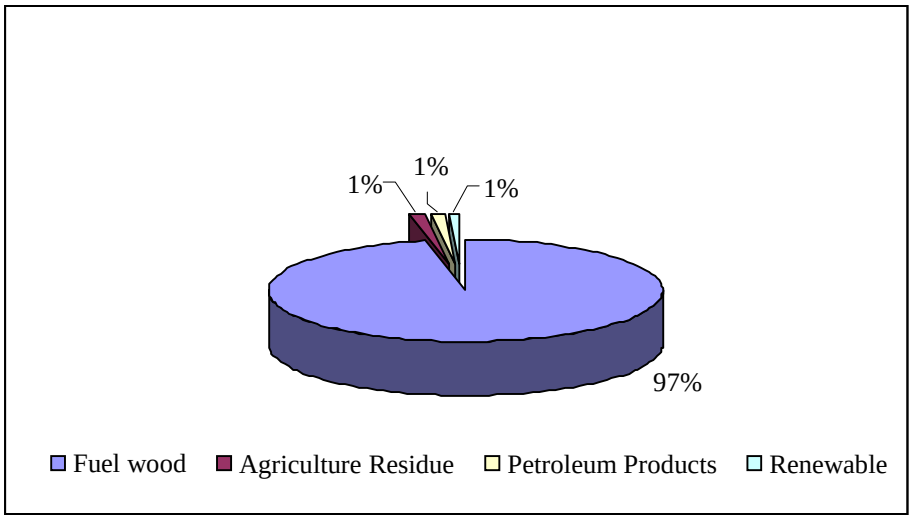
Table No: 5.8 Total Energy Supply per year by Respondent HHs

SN	Energy Sources	Unit	Amount	Kg/Ltr /KWH	In 1000 Units	Conversion Factor	GJ
1	Fuel Wood	Bhari	17954	718160	718.16	16.75	12029.18
2	Agr. Residue	Bhari	334	13360	13.36	12.56	167.80
3	Keresone	Ltr	3836	3836	3.836	36.26	139.09
4	L P Gas	Cyl.	35	497	0.497	49.24	24.47
5	Electricity from MHP	KWH	21419	21419	21.419	3.6	77.11
6	Solar Electricity	KWH	2620	2620	2.62	3.6	9.43
Total energy supply in GJ							**12447.09**
Per capita Energy Supply in GJ							**6.17**

Source: Field Survey, 2008.

According to the above table, the total energy supply by respondent HH (260 HH) is 12453.80 GJ. The per capita per year energy supply is only 6.17 GJ which is very less amount. Out of total energy supply the, 97 % of energy supply from the fuel wood. Likewise, 1% energy supply from agriculture residue, 1% from the Petroleum products and 1% from renewable energy sources, which is presented in figure no 5.10.

Figure No: 5.10 Energy Supply by Sources



Source: Field Survey, 2008.

5.2.3 Total Energy Supply by Seasons in Respondent HHs

Energy supply is depends up on the demand of the energy, time and seasons. In rainy seasons, there is difficult to collect the fuel wood resources. The supply of energy resources in summer and winter seasons have summarized in table no.5.9.

Table No: 5.9 Total Energy Supply by Seasons in Respondent HHs

SN	Energy Sources	Unit	Supply			Percent	
			Summer	Winter	Total	Summer	Winter
1	Fuel wood	Bhari	7659	10295	17954	42.66	57.34
2	Agr. Residue	Bhari	58	276	334	17.37	82.63
3	Kerosene	Ltr	1934	1902	3836	50.42	49.58
4	L P Gas	Cyl.	17	18	35	48.57	51.43
5	Electricity from MHP	KWH	10741	10678	21419	50.15	49.85
6	Solar Electricity	KWH	1310	1310	2620	50.00	50.00

Source: Field Survey, 2008.

According to table no 5.9, 42.66% fuel wood has been collected in summer where as 57.34 % fuel wood has been collected in winter. Similarly, Agriculture residue has been collected mainly is winter season (82.63%). Only few amount of agriculture residue have collected in summer season. There is no significance difference between the summer and winter in other

energy resources i.e. kerosene, LP gas and electricity from MHP and solar energy.

5.2.4 Energy Consumption pattern of Respondent HHs

Rural household in Nepal are largely depended on fuel wood and agriculture residue. For the country as a whole, the fuel wood production is in deficit. Petroleum product (Kerosene, L P gas etc.) is supplied entirely through imports. The share of alternative energy supply is negligible in national context.

The energy consumption scenario in respondent households by sources is presented in table no 5.10.

Table No: 5.10 Energy Consumption by Sources in Respondent HHs

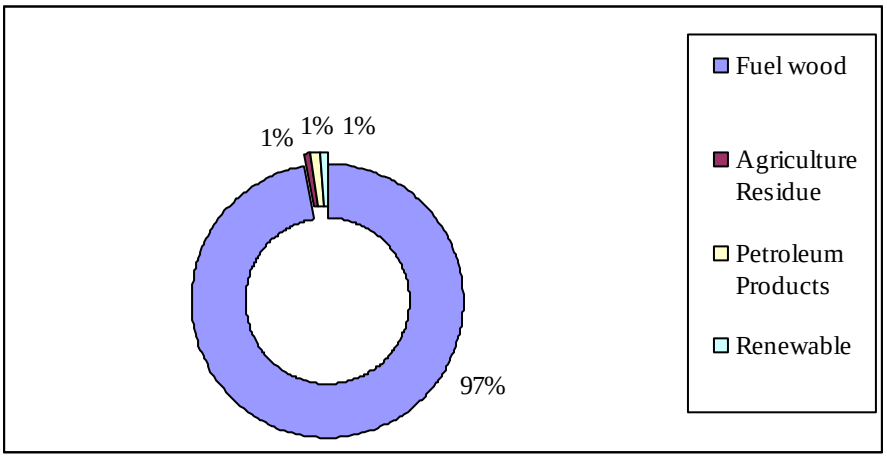
SN	Energy Sources	Unit	Total	Kg/Ltr/ KWH	In 1000 Units	Conversion Factor	GJ
1	Fuel wood	Bhari	17678	707120	707.12	16.75	11844.26
2	Agr. Residue	Bhari	328	6560	6.56	12.56	82.39
3	Keresone	Ltr	3836	3836	3.836	36.26	139.09
4	L P Gas	Cylinder	26	369.2	0.3692	49.24	18.18
5	Electricity from MHP	KWH	21419	21419	21.419	3.6	77.11
6	Solar Electricity	KWH	2620	2620	2.62	3.6	9.43
Total Energy Consumption in GJ							**12170.47**
Per capita per year energy consumption in GJ							**6.03**

Source: Field Survey, 2008.

According to the table no. 5.10, the total energy consumption by respondent HH (260 HH) is 12177.18 GJ. The per capita per year energy supply is only 6 GJ which is very less amount. In National figure, the per capita energy consumption per year is 14.6 GJ. In to the respondent households (260 HHs), 11,844.26 GJ energy consumes from fuel wood, mainly collected from government forests.

Out of total energy consumption, 97 % of energy supply from the fuel wood. Likewise, 1 % energy supply from agriculture residue, 1% from the Petroleum products and 1% from renewable energy sources, which is presented in figure no 5.11.

Figure No: 5.11 Energy consumption by sources



Source: Field Survey, 2008.

5.2.5 Sustainable fuel wood supply in Kotdarbar VDC

Fuel wood is the main sources of energy in rural area of Nepal. The sustainable fuel wood supply in Kotdarbar VDC is presented in table no. 5.11.

Table No: 5.11 Sustainable fuel wood supply in Kotdarbar VDC

Ward no.	No. of HH	Total sustainable fuel wood supply		Forest land Ha	Farm area, Ha
		Ton	GJ		
1	169	270	4519	695	272
2	111	177	2968		
3	85	136	2273		
4	137	219	3664		
5	63	101	1685		
6	128	204	3423		
7	102	163	2728		
8	128	204	3423		
9	118	188	3156		
Total	**1041.00**	**1662**	**27839**	**695**	**272**

Source: Field Survey, 2008

According to table no. 5.11, the sustainable fuel wood supply in Kotdarbar VDC is only 1662 ton. There is 695-hector forest land and 272 hector farm land. In whole VDC, sustainable energy from fuel wood resources is 27839 GJ.

5.2.6 Annual Fuel wood consumption in Kotdarbar VDC

The overall energy consumption of Nepal is largely dominated by the use of traditional non-commercial forms of energy such as fuel wood, agricultural residues and animal waste. Fuel wood is the main energy sources (76% of total consumption) in national context. Annual fuel wood consumption in Kotdarbar VDC is shown in table no 5.12.

Table No: 5.12 Annual Fuel wood consumption in Kotdarbar VDC

Ward no.	No. of HH	Annual Fuel wood Consumption			
		Average in Bhari	Total in Bhari	Total in Ton	Total in GJ
1	169	37.17	6281.85	251.27	4208.84
2	111	87.64	9728.36	389.13	6518.00
3	85	69.05	5869.47	234.78	3932.55
4	137	85.09	11657.84	466.31	7810.76
5	63	44.18	2783.45	111.34	1864.91
6	128	73.50	9408.00	376.32	6303.36
7	102	88.81	9059.11	362.36	6069.60
8	128	79.97	10235.73	409.43	6857.94
9	118	45.64	5385.52	215.42	3608.30
Total	**1041**	**67.90**	**70409.35**	**2816.37**	**47174.26**

Source: Field Survey, 2008

Table no. 5.12 shows that 2816.37ton fuel wood consumption annually in Kotdarbar VDC and average fuel wood consumption per households is 67.90 Bhari (i.e. 2.7 ton) in kotdarbar VDC. In total 47174.26 GJ energy consumed from fuel wood in kotdarbar VDC annually.

5.2.7 Scenario of Sustainable Fuel wood Supply, Consumption and Balance

The sustainable fuel wood supply, consumption and balance in shown in table no 5.13.

Table No: 5.13 Sustainable Fuel wood Supply, Consumption and Balance

Ward no.	No. of HH	Sustainable Supply		Consumption in GJ		Balance in GJ	
		In Ton	In GJ	In Ton	In GJ	In Ton	In GJ
1	169	270	4519.41	251.27	4208.84	18.54	310.57
2	111	177	2968.37	389.13	6518.00	-211.92	-3549.63
3	85	136	2273.08	234.78	3932.55	-99.07	-1659.47
4	137	219	3663.66	466.31	7810.76	-247.59	-4147.09
5	63	101	1684.75	111.34	1864.91	-10.76	-180.16
6	128	204	3422.99	376.32	6303.36	-171.96	-2880.37
7	102	163	2727.69	362.36	6069.60	-199.52	-3341.91
8	128	204	3422.99	409.43	6857.94	-205.07	-3434.96
9	118	188	3155.56	215.42	3608.30	-27.03	-452.73
Total	**1041**	**1662**	**27838.50**	**2816.37**	**47174.26**	**1154.37**	**19335.76**

Source: Field Survey, 2008

According to table no 5.13, the sustainable fuel wood supply in Kotdarbar VDC is only 1662 ton where as annual consumption is 2816.37 ton. There is over uses of 1154.37 ton fuel wood annually which has adverse effect on sustainable development. The prevailing pattern of energy use is unsustainable which has created adverse impacts of the condition of the rural livelihoods.

5.2.8 Hydro power Resources in Kotdarbar VDC

The existing and poterntial hydro power resources in Kotdarbar VDC is presented in table below.

Table No: 5.14 Hydro power Resources in Kotdarbar VDC

Ward no.	No. of HH	Name of the scheme	Output (KW)	MWH (Annual)	Energy (GJ)
1	169	Lima Khola MHP	12	103.68	373.25
2	111	Peltric Set	1.5	12.96	46.66
3	85				
4	137	Wanja Khola MHP	13	112.32	404.35
5	63				
6	128	Likandi Khola MHP	20	172.8	622.08
7	102				
8	128				
9	118				
Total	**1041**		**46.5**	**402**	**1446**

Source: PRA, 2008

In kotdarbar VDC three MHP had been already completed and ward no 1,4,5,6 and some households of ward no 7 are already electrified. Out of 1041 HHs , 447 HHs have already electrified from three MHP. There is potentiality of 1.5 KW peltric set in ward no. 2. In kotdarbar VDC, 46.5 KW hydropower potential, having 1446 GJ energy annually.

5.3 An Overview Study of Renewable Energy Technologies (RETs)

Renewable Energy Technology (RET) is a synonym for a new, renewable and nion conventional forms of energy i.e. the technologies, which use local energy resources (Other than commercial fuels) and biomass fuel (firewood, agriculture residue and animal wastes) in traditional forms. The main sources of these alternatives are biomass, water, sun and air. (Devkota, 2007:1). Renewable energy can play the role of catalyst in rural development by providing a modern form of energy.

In this section, the overview status of Renewable Energy Technology has been presented.

5.3.1 Installation of RETs by Respondent HHs:

Renewable Energy Technology is a modern form of the alternative energy which can play a significant role for rural development. RETs assume to act as a prime engine in diversifying economic activities in Nepal, as well as meeting the energy requirement of the majority of the rural households. So, the installation of RETs is essential for sustainable development. The installation of RETs in respondents HHs is presented in table no.5.15.

Table No: 5.15 Installation of RETs in Respondent HHs

Installation	No. of Respondents	Percent
Yes	149	57.31
No	111	42.69
Total	**260**	**100.00**

Source: Field Survey, 2008

According to table no 5.15, out of 260 respondent households, 149 HHs (57.31%) have installed any one or more renewable energy technologies where as 111 HHs (42.69%) have not installed any renewable energy technologies yet.

5.3.2 Typology of RET installed in Sampling Households

The main sources of renewable energy technology are biomass, water, sun and air. The major typology of RET installed in rural areas of Nepal are: biogas, improve cook stove, micro-hydro power, solar home system, solar dryer etc. The type of renewable energy technology installed in respondent households is presented in table no 5.16.

Table No: 5.16 Types of RET installed in Respondent HHs

SN	Type of RET	Number of Respondent HHs	Percent
1	BG	2	1.34
2	BG,MHP	5	3.36
3	ICS	1	0.67
4	ICS,MHP	5	3.36
5	ICS,SHS	1	0.67
6	MHP	108	72.48
7	SHS	16	10.74
8	SHS,MHP	9	6.04
9	SHS,MHP,ICS	2	1.34
Total		**149**	**100.00**

Source: Field Survey, 2008.

Table no. 5.16 shows that out of the 149 HHs, most of the HH have been electrified from Micro Hydro. There are two or more renewable energy technologies have been installed 20 HH. Out of the 149 HHs, 108 HHs have only electrified from MHP. Nine HHs have MHP as well as solar home system, five HHs have MHP as well as ICS. Similarly, 16 HHs have SHS only, two HHs have biogas only, one HHs has ICS only, and two HHs have ICS, MHP and SHS.At the time of the repair and maintenance of MHP, some people have purchased SHS for lighting purpose. So, 11 HHs have been electrified with SHS and MHP.

5.3.3 Ward wise Installation Status of Renewable Energy Technology in Kotdarbar VDC:

The ward wise installation status of RETs in Kortdarbar VDC is presented in table no. 5.17.

Table No: 5.17 Ward wise installation status of RETs in Kotdarbar VDC

SN	Type of RET	Ward Numbers									Total
		1	2	3	4	5	6	7	8	9	
1	MHP Electricity	115	0	0	122	63	104	40	0	3	**447**
2	SHS	25	5	2	5	1	1	35	10	11	**95**
3	Bio-gas	18	0	0	32	0	12	6	0	1	**69**
4	ICS	11	4	5	29	4	20	1	11	15	**100**
Total											**711**

Source: PRA, 2008

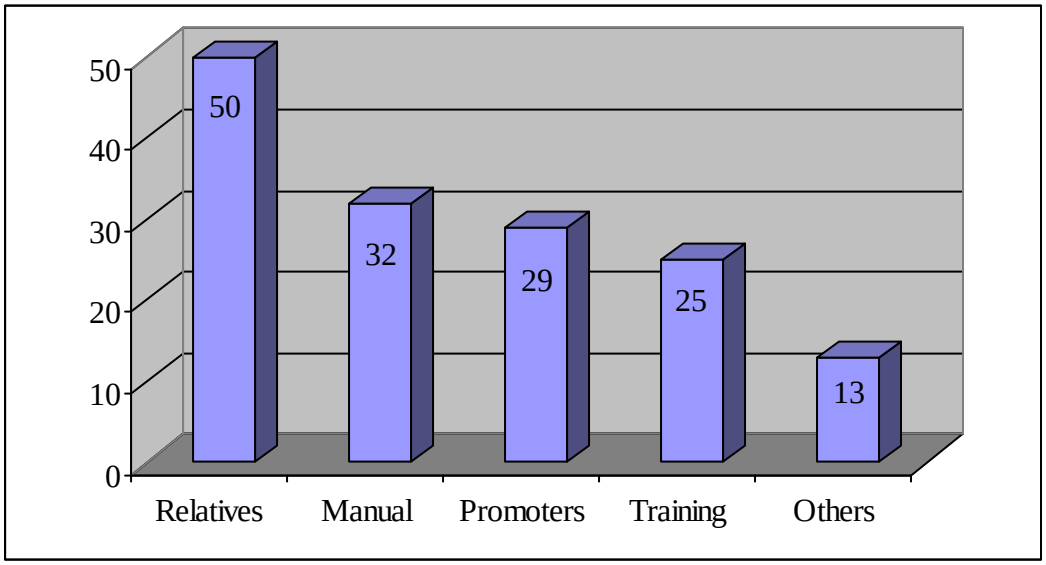
According to table no. 5.17, out of total households (1041 HHs) in Kotdarbar VDC, 447 HHs have been electrified from micro hydro power. 95 HHs have SHS for lighting, 69 HHs have installed biogas plants and100 HHs installed ICS.

5.3.4 Sources of Information about RETs

There are many sources for information/dissemination of RETs like as brochure, manual, FM broadcasting, training manual, neighbours/relatives, promoters etc.

Figure no. 5.12 shows that the sources of information about RETs.

Figure No: 5.12 Sources of Information about RETs



Source: Field Survey, 2008.

According to figure no. 5.12, out of 149 respondents, 50 respondents answered that they have obtained information from relatives. Like wise, 32 respondents from manual, 29 respondents from promoters, 25 respondents from training and 13 respondents from others respectively.

5.3.5 Effectiveness of Renewable Energy Technology

Renewable energy technologies have good impact in social, economical as well as development sector. However, there may be negative effect from the installation of RETs like as chances of electric shock, increase in workload. The effectiveness of RETs is presented in table no. 5.18.

Table No: 5.18 Effectiveness of Renewable Energy Technology (RET)

SN	Effectiveness	No. of Respondents	Percent
1	Better Education	51	34.23
2	Increase in work load	33	22.15
3	Decrease in workload of woman	30	20.13
4	Health improve	22	14.17
5	Firewood saving	8	5.37
6	Decrease in financial load	4	2.68
7	Access in communication	1	0.67
	Total	**149**	**100.00**

Source: Field Survey, 2008

Table no. 5.18 shows that out of 149 respondents, 51 (34.23%) respondents have stated that their children have progress in education from the lighting. Similarly, 33 (22.15%) respondents replied that they have increase in work load due to the lighting, especially from women, they have to do their household work at night also (Such as grinding in Janto, husking in Dhikki etc). Likewise, 30 (20.13%) respondents stated decrease work load of women especially from the construction of biogas plant and ICS, 22 (14.17) respondents replied health improve, 8 (5.37) respondents replied firewood saving, 4 (2.68%) respondents replied decrease in financial load and 1 replied access in communication.

5.3.6 Preference ranking of RETs in Kotdarbar VDC

Preference ranking is one of the important tools of PRA, which is used to identify and prioritize the requirements/needs of the local community. At the time of PRA, communities have actively participated and they prioritized their needs/requirements about RETs. Ward wise preference ranking of RETs in Kotdarbar VDC is presented in table no. 5.19.

Table No: 5.19 Ward wise Preference Ranking of RETs in Kotdarbar VDC

SN	RETs	Ward No.									Total	Preference
		1	2	3	4	5	6	7	8	9		
1	ICS	6	5	6	6	6	6	6	6	5	52	**First**
2	Bio-Gas	5	6	3	5	5	5	5	5	6	45	**Second**
3	Micro-hydro	2	3	5	4	4	2	2	2	2	26	Fourth
4	SHS	3	4	4	3	3	3	3	4	4	31	**Third**
5	Solar Tuki	4	1	2	2	2	4	1	3	3	22	Fifth
6	Peltric Set	1	2	1	1	1	1	4	1	1	13	Sixth

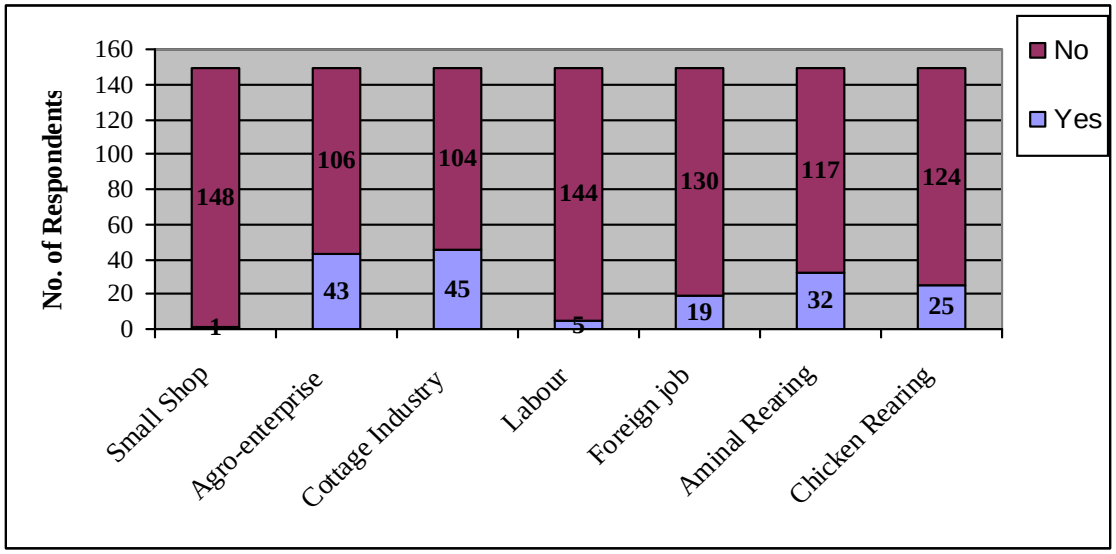
Source: PRA, 2008

In table no. 5.19, the highest mark i.e 6 indicates the first priority and lowest mark i.e 1 indicates the last priority of RETs. Similarly, the sum of the highest mark indicates the first priority and lowest mark indicate the last priority in whole VDC. According to above table, ICS implies in first priority in ward numbers 1,3,4,5,6,7 & 8 and biogas comes in first priority in ward numbers 2 & 9.SHS is in third priority in ward numbers . Likewise, in whole VDC, ICS, Biogas and SHS are placed in first, second and third priority respectively. Three micro hydro plants had already completed and 447 HHs have benefitted from MHP. So, MHP is in less priority comparison with ICS, Biogas and SHS.

5.3.7 Employment Diversification from the installation of RETs

Developing countries like Nepal have been facing the unemployment problem. RET supports to employment diversification in different development sector and small enterprises in rural areas. Figure no. 5.13 shows the employment diversification from the installation of RETs.

Figure No: 5.13 Employment Diversification from the installation of RETs



According to figure no. 5.13, there is more employment diversified in agro-enterprise, cottage industry and chicken rearing after the installation of RETs. There is no significance effect in employment diversification in the small shop, labour and foreign job. RET supports to employment diversification in different development sector and small enterprises in rural areas. However the more no. of respondents replied that there is no employment diversified from the installation of RETs.

5.3.8 Comparison of Monthly Energy Consumption before and after the RET installation

From the installation of RETs, there is not only increase the living standard but also saving in time and energy resources. If the community is electrified through MHP or Solar, there is no need to supply kerosene. Similarly from the installation of ICS and Bio gas plants, there is fuel wood saving as well as reduce the time to collect the firewood. Consumption of energy resources before and after the RETs installation is presented in table no. 5.20.

Table No: 5.20 Monthly Energy Consumption by Respondent HHs Before and After the Installation of RETs.

SN	Energy Sources	Unit	Monthly Consumption by Respondent Households		
			Before	After	Saving
1	Fuel Wood	KG	46400	40560	5840
2	Agri.Residue	KG	1860	1860	0
3	Kerosene	Ltr.	548	254	294
4	Electricity	KWH	0	1265	-1265
5	Dry Battery	Nos	343	110	233

Source: Field Survey, 2008.

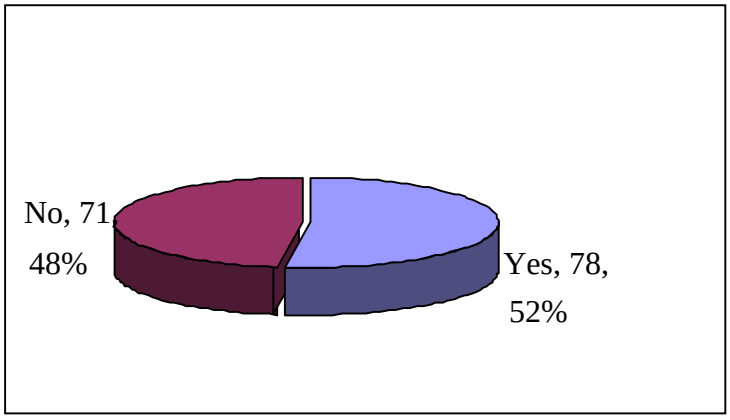
According to table no.5.20, 5840 kg fuel wood has been saved in 149 HHs. From the calculation it is comes to know that one household have saved 34 kg fuel wood monthly. Similarly 294 liter kerosene have been saved in 149 HHs (One HH saved 1.98 ltr. kerosene monthly). Similarly 233 numbers of dry cell have been saved in 149 HHs. However, 149 households are using 1265 KWH electricity after the installation of RETs.

5.3.9 Leisure time due to the installation of RETs

The main advantage of RET is time saving. After the installation of ICs and Biogas plants, there is less time needed to collect the firewood. From the electricity from MHP, there is no significance different in time saving.

Out of 149 respondents, 78 (52%) respondents stated that they have saved their time after the installation of RETs and have a leisure time and 71 (48%) respondents have replied that they have no leisure time after the installation of RETs mainly the respondents who have a electricity in their households, which is presented in figure 5.14.

Figure No: 5.14 Leisure time due to the Installation of RETs

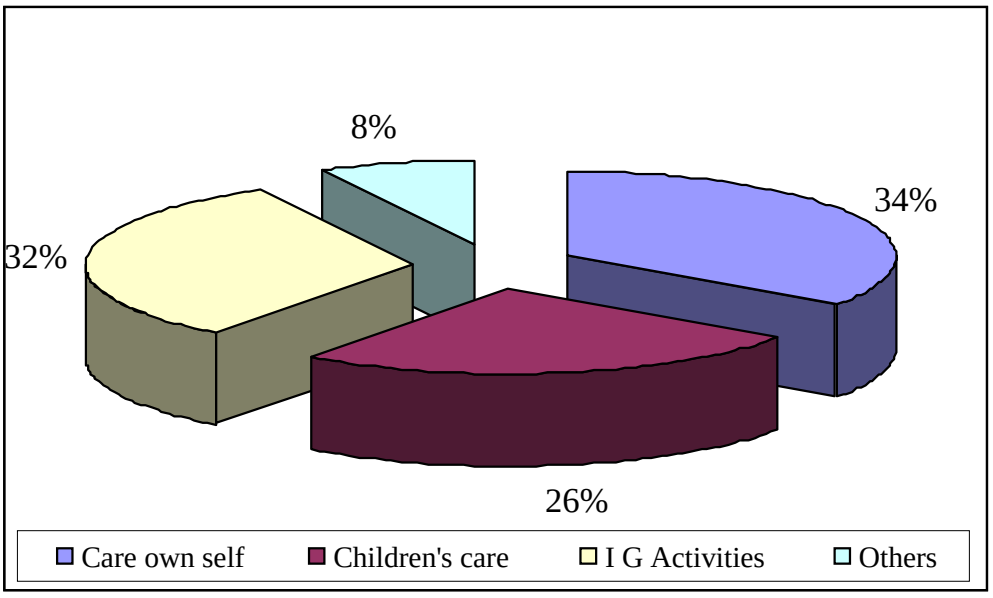


Source: Field Survey, 2008.

5.3.10 Use of Leisure Time by Respondent HHs

After the installation of ICs and Biogas plants, there is less time needed to collect the firewood and have a leisure time especially for women and children. Some of the people have been utilizing the leisure time in productive ways (like as vegetable farming, chicken raring etc.). The activities which are done in leisure time are presented in figure no.5.15.

Figure No: 5.15 Uses of Leisure time



Out of 78 respondents who have stated they have leisure time after the installation of RETs, 34% stated that they are using their time doing care own self. 32 % replied that they have time for children care. Likewise, 26% stated as income generating activities and 8% replied others.

5.3.11 Satisfaction from the installation of RETs

The satisfaction from the installation of RETs is presented in table below.

Table No: 5.21 Satisfactions from the Installation of RETs.

SN	Satisfaction	No. of Respondents	Percent
1	Medium	141	94.63
2	More	8	5.37
3	Not satisfaction	0	0.00
Total		**149**	**100.00**

Source: Field Survey, 2008.

According to table no. 5.21, out of 149 respondents, 141 (94.63%) respondents replied that they have medium level of satisfaction from the installation of RETs. Similarly, 8 (5.37%) respondents stated that they have more satisfied from the installation of RETs.

5.4 Hypothesis Testing

In present research study, two hypotheses have been set up and tested statistically using z- test.

"The annual income of RETs users is greater than the non-users of RETs or Higher the income of the household, there is more possibility to use of RETs."

5.4.1 Hypothesis 1

In an average, Nepal's per capita energy consumption is 14.6 GJ per year. The first hypothesis is;

"In the context the rural area of Nepal, per capita energy consumption is less than 14.6 GJ."

Null hypothesis:

H_0: $\Uparrow$ = 14.6 (The average energy consumption is 14.6 GJ)

Alternative Hypothesis:

H_1: $\Uparrow$ < 14.6 (The average energy consumption is less than 14.6 GJ)

From the calculation of primary data, the following parameters have been obtained.

Sample Size (n) = 260

Mean ($\bar{x}$) = 6.03

$\phi (x - \bar{x})^2 = 2379.43$

So Standard Deviation (S) = $[1/ (n-1) * \phi (x - \bar{x})^2] = 3.03$

Under H_0, we have the test statistics,

$$Z = \frac{(\bar{x} - \Uparrow)}{(S/\sqrt{n})} = \frac{6.03 - 14.6}{3.03 / \sqrt{260}} = 45.60$$

$\therefore Z = 45.60$

Level of Significance ($\Im$) = 5% = 0.05

Critical Value:

The tabulated value of Z at 5% level of significance for one tail test is 1.645.

Decision:

Calculated Z > Tabulated Z

So, Null hypothesis (H_0) is rejected which means alternative hypothesis (H_1) is accepted; i.e. the average energy consumption is less than 14.6 GJ.

5.4.2 Hypothesis 2

"The annual income of RETs users is greater than the non-users of RETs or Higher the income of the household, there is more possibility to use of RETs."

Null hypothesis:

H_0: $\Uparrow_1 = \Uparrow_2$ (There is no significance difference in income of RET users and Non users of RET)

Alternative Hypothesis:

H_1: $\Uparrow_1 > \Uparrow_2$ (Income of RET users is greater than Non users of RET)

From the calculation of primary data, the following parameters have been obtained.

RET Users:

Sample Size (n_1) = 149

Mean ($\bar{x}_1$) = 146.95 (000' NRs)

$\phi (x_1 - \bar{x}_1)^2$ = 1600166

Standard Deviation (S_1) = $[1/ (n_1-1) * \phi (x1 - \bar{x}_1)^2]$ = 103.98

So, S_1^2 = 10811.93

Non Users of RET:

Sample Size (n_2) = 111

Mean ($\bar{x}_2$) = 159.17 (000' NRs)

$\phi (x_2 - \bar{x}_2)^2$ = 9215406

Standard Deviation (S_2) = $[1/ (n_2-1) * \phi (x_2 - \bar{x}_2)^2]$ = 289.44

So, S_2^2 = 83776.42

Under H_0, we have the test statistics,

$$Z = \frac{(\bar{x}_1 - \bar{x}_2)}{[(S_1^2 / n_1)/ (S_2^2 / n_2)]} = \frac{(146.95-159.17)}{[(10811.93 / 149)/ (83776.42/ 111)]} = 0.424$$

$\therefore Z = 0.424$

Level of Significance ($\Im$) = 5% = 0.05

Critical Value:

The tabulated value of Z at 5% level of significance for one tail test is 1.645.

Decision:

Calculated Z < Tabulated Z

So, Null hypothesis (H_0) is accepted which means alternative hypothesis (H_1) is rejected; i.e. there is no reason to say the income of RET users is greater than non users of RET.

CHAPTER: VI SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary of Findings

- **Household size**
  34.62% households have 4 to 6 numbers of family members,27.31% households have 7 to 9 numbers of family members. The average family size of the sample HHs is 7.8, this data is greater than the CBS figures (i.e. average family size is 5.89).

- **Caste and Ethnicity Composition**
  Out of the 1041 HHs in whole VDC, amongs are Magars (79.06%).

- **Gender Composition of the Respondents**
  Out of 260 respondents, 173 are male and only 87 are female.

- **Family Type of Respondents**
  Out of 260 respondents' households, there is 75% Joint and 25% single family.

- **Education Status of the sampling Population**
  Out of total 2018 no. of population, 81% male are literate where as 67% female are literate.

- **Occupation**
  Most of the respondents are involved in agriculture. Out of 260 respondents 251 (96.54%) are dependent to agriculture for there livelihood. Only 7 respondents stated the foreign job/ pension as their occupation.

- **Land holding Pattern and Types of Land Use**
  The most of the respondents (38.46%) have only 1 to 5 ropanies of land. 25% respondents have 6 to 10 ropani of land, 20.77 % have 11 to 15 ropani, 6.54% have 16 to 20 ropani and 9.23 % have 21and above respectively.
  Similarly most of the land (59%) have been using as Bari (Non irrigated land),29% of lands have been using as Khet (Irrigated land), 9 % of lands

have been using as a plantation and 3% of land have been using as a Buttyan.

- **Livestock of Respondent's Family**

  33.46 % of total respondents have 11 to 20 no. of livestock including Buffalo, Cow, Goat, Chicken/Duck and Pigs. 24.62% have 1 to 10 numbers, 25.38% have 21-30 numbers, and 11.34% have 31-40 numbers of livestock.

- **Food Sufficiency from Agriculture Production**

  Out of total 1041 HHs in Kotdarbar VDC, 205 HHs (19.69%) household have the worst condition and they have food insufficiency,424 HHs (40.73%) have food sufficient up to 6 months from their own agriculture production, 335 HHs (32.18%) have food sufficiency for 9 months. There is only 77 HHs (7.4%) have food sufficient for whole year.

- **Roof Type of House in Kotdarbar VDC**

  In Kotdarbar VDC, there is 52% household have stone roof, 29% household have khar roof and 19% household have CGI roof.

- **Major Sources of Income of Respondents**

  Foreign job is the main sources of income in to the sampling households. 68 % income is earned from foreign countries. Agriculture (21%) is the second main income sources. 9 % income earned from job in home country and labour. Only 2% income earned from business.

- **Total Expenditure of Respondents in Different Heading**

  Out of total expenses 50% in food, 15% expenditure in clothes, 13 % in health, 12% in education, 4 % in social activity, 3% in fuel and 3% in others respectively.

  78% of total expenses used to fulfilling the basic needs of human beings.

- **Major Sources of Fuel Wood Supply:**

  Government forest is the main sources of fuel wood supply. 66% of total fuel wood has been collected from government forest,29% fuel wood has collected from agro inclusion, 4% from community forest and 1% from private forest.

- **Energy Supply by Respondent HHs**

  The total energy supply by respondent HH (260 HH) is 12453.80 GJ. The per capita per year energy supply is only 6.17 GJ which is very less amount. Out of total energy supply, 97 % of energy supply from the fuel wood. Likewise, 1% energy supply from agriculture residue, 1% from the Petroleum products and 1% from renewable energy sources.

- **Total Energy Supply by Seasons**

  42.66% fuel wood has been collected in summer where as 57.34 % fuel wood has been collected in winter. Similarly, Agriculture residue has been collected mainly is winter season (82.63%). There is no significance difference between the summer and winter in other energy resources i.e. kerosene, LP gas and electricity from MHP and solar energy.

- **Energy Consumption pattern of Respondent HHs**

  The total energy consumption by respondent HH (260 HH) is 12177.18 GJ. The per capita per year energy consumption is only 6 GJ which is very less amount. In National figure, the per capita energy consumption per year is 14.6 GJ.

  Out of total energy consumption, 97 % of energy supply from the fuel wood. Likewise, 1 % energy supply from agriculture residue, 1% from the Petroleum products and 1% from renewable energy sources.

- **Sustainable fuel wood supply in Kotdarbar VDC**

  The sustainable fuel wood supply in Kotdarbar VDC is only 1662 ton. There is 695 hector forest land and 272 hector farm land. In whole VDC, sustainable energy from fuel wood resources is 27839 GJ.

- **Annual Fuel wood consumption in Kotdarbar VDC**

  In Kotdarbar VDC, 2816.37 ton fuel wood have consumed annually and average fuel wood consumption per households is 67.90 Bhari (i.e. 2.7 ton) in . In total 47174.26 GJ energy have consumed from fuel wood in kotdarbar VDC annually.

- **Scenario of Sustainable Fuel wood Supply, Consumption and Balance**

  The sustainable fuel wood supply in Kotdarbar VDC is only 1662 ton where as annual consumption is 2816.37 ton. There is over uses of 1154.37 ton fuel wood annually which has adverse effect on sustainable development.

- **Hydro power Resources in Kotdarbar VDC**
  In kotdarbar VDC, out of 1041 HHs , 447 HHs have already electrified from three MHP. In kotdarbar VDC, 46.5 KW hydropower potential and contribute 1446 GJ energy annually.

- **Installation of RETs by Respondent HHs:**
  Out of 260 respondent households, 149 HHs (57.31%) have installed any one or more renewable energy technologies where as 111 HHs (42.69%) have not installed any renewable energy technologies yet.

- **Typology of RET installed in Sampling Households**
  Out of the 149 HHs, most of the HH have been electrified from Micro Hydro. There are two or more renewable energy technologies have been installed 20 HH. Out of the 149 HHs, 108 HHs have only electrified from MHP. Nine HHs have MHP as well as solar home system, five HHs have MHP as well as ICS.

- **Ward wise Installation Status of Renewable Energy Technology in Kotdarbar VDC:**
  Out of total households (1041 HHs) in Kotdarbar VDC, 447 HHs have been electrified from micro hydro power. 95 HHs have SHS for lighting, 69 HHs have installed biogas plants and100 HHs installed ICS.

- **Sources of Information about RETs**
  Out of 149 respondents, 50 respondents have obtained information from relatives. Like wise, 32 respondents from manual, 29 respondents from promoters, 25 respondents from training and 13 respondents from others respectively.

- **Effectiveness of Renewable Energy Technology**
  Out of 149 respondents, 51 (34.23%) respondents have stated that their children have progress in education from the lighting. 33 (22.15%) respondents replied that they have increase in work load due to the lighting.Likewise, 30 (20.13%) respondents stated decrease work load of women especially from the construction of biogas plant and ICS, 22 (14.17) respondents replied health improve, 8 (5.37) respondents replied firewood saving, 4 (2.68%) respondents replied decrease in financial load and 1 replied access in communication.

- **Preference ranking of RETs in Kotdarbar VDC**

  ICS is in first priority in ward numbers 1,3,4,5,6,7 & 8 and biogas comes in first priority in ward numbers 2 & 9.SHS is in third priority in ward numbers . Likewise, in whole VDC, ICS, Biogas and SHS are placed in first, second and third priority respectively.

- **Employment Diversification from the installation of RET**

  There is more employment diversified in agro-enterprise, cottage industry and chicken rearing after the installation of RETs. There is no significance effect in employment diversification in the small shop, labour and foreign job.

- **Comparison of Monthly Energy Consumption before and after the RET installation**

  There is 5840 kg fuel wood has been saved in 149 HHs. From the calculation it is comes to know that one household have saved 34 kg fuel wood monthly. Similarly 294 liter kerosene has been saved in 149 HHs (One HH saved 1.98 ltr. kerosene monthly). Similarly 233 numbers of dry cell have been saved in 149 HHs.

- **Leisure time due to the installation of RETs**

  Out of 149 respondents, 78 (52%) respondents have a leisure time and 71 (48%) respondents have replied they have no leisure time.

- **Use of Leisure Time by Respondent HHs**

  Out of 78 respondents, 34% stated that they are using their time doing care own self. 32 % replied that they have time for children care. Likewise, 26% stated as income generating activities and 8% replied others.

- **Satisfaction from the installation of RETs**

  Out of 149 respondents, 141 (94.63%) respondents have medium level of satisfaction and 8 (5.37%) respondents have more satisfied from the installation of RETs.

6.2 Conclusion

In this heading, an attempt has bee made to conclude the whole research. The major energy resources base in Nepal consists of Biomass, Hydro electricity, petroleum products and renewable energy technologies. Among the entire energy resources base, it is evident that biomass is the dominant resource base of the country with respect to its utilization. Commercial forms of energy are not known to exist in any significant amount. Renewable energy can play the role of catalyst for the poverty reduction by providing the modern forms of energy. Renewable energy is ckeab energy and its uses for cooking and lighting reduce the pollution and health hazards. However, RETs have not been massively disseminated in Nepal as compared their technical possibilities and should not be done proper assessment of energy resources to meet the energy needs of rural people.

In this regard, this research study was mainly concentrated in assessment of rural energy resources and overview study of RET and the following conclusion are drawn from the research work carried out in to the study area which as under.

- Most of the young generations have gone to foreign country for labour. Due to the lack of productive labour, there is low productivity in agriculture sector.
- The majority of the household have facing the problem to fulfill their basic needs (Food, Cloth and Housing)
- There is low level of subsistence in to the study area.
- Government forest is the main sources of fuel wood supply, which means there is more pressure in forest.
- The per capita per year energy supply in study area is only 6.17 GJ which is very less amount.
- Fuel wood is the major sources of energy in rural areas. Out of total energy supply, 97 % of energy supply from the fuel wood, 1% energy supply from agriculture residue, 1% from the Petroleum products and 1% from renewable energy sources.
- More amount of fuel wood consumes in winter season than summer.
- The average per capita per year energy consumption is only 6.03 GJ where as in national average it is 14.6 GJ.
- The sustainable fuel wood supply in Kotdarbar VDC is only 1662 ton where as annual consumption is 2816.37 ton. With regard to the supply and consumption balance of fuel wood,there is deficit of 1154.37 ton fuel wood annually which has adverse effect on sustainable development.

- A hydro poewer resource is the more potential renewable energy sources.In kotdarbar VDCof Tanahun, 46.5 KW hydro power potential and contributes 1446 GJ energy annually.
- About 57% of total households have been installed the any one of the Renewable Energy Technologies (RETs). However, Renewable Energy Technologies have not been massively disseminated on Nepal as compered to their technical viability.
- The major RETs, which are practicable in rural area, are Micro hydropower, Biogas, solar home system and improved cook stove. These technologies have been proven to be viable alternative energy technologies in Nepal.
- There is no reason to say that the income status of RET users is greater than non users of RETs, i.e. there is more chances of promote RETs in rural areas even though the income status of rural people is low.
- The major positive impacts of RETs are help to better education, time save, reduce the workload of women, firewood saving and health improve.
- There is so much demand to install the Improved Cook Stove in rural areas.
- RETs have no significance effort to employment diversification in rural areas. Electricity from MHP is using only for lighting.
- After the installation of RETs, there is leisure time in to the community and most of the leisure time has been used as non-productive. Almost of the RETs users have not done the income generating activities.
- Almost of the users have more satisfied after the installation of RETs. There is no any adverse effect of RETs to rural community.

6.3 Recommendations

The recommendations are prepared on the basis of the finding and conclusion of the study area as under:

Recommendation to Government and Line Agencies

1. Renewable Energy Technology should be massively disseminated in rural area, which helps to sustainable rural development and poverty alleviation.
2. Government and concern agencies should pay attention about the rapidly growing deforestation and should focus to promote the community forest.
3. Development and Promotion of RET should be made an integral part of overall rural development.
4. The energy planning from the bottom level should be done with proper assessment of resources in local level to meet the energy need of people.
5. Research and Development should be done to promote the technically viable renewable energy sources like as wind energy.
6. Private sector needs to be encouraged to play an important role in the development and dissemination of the RETs.

Recommendation to NGO/INGOs:

1. Concern NGOs, I/NGOs and other organization should formulate and implement appropriate policies and develop networking with several institutions to promote the renewable energy technologies.

Recommendation for further Study

1. Further Assessment of Rural Energy Resources should be done with focusing all existing as well as possible energy resources.

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APPENDICES

Appendix A: Questionnaire for Household Survey

1. General Information

Date: ……..

Location: 1. District:…… 2. VDC:…… 3. Ward No.:……

Name of Interviewer:……..

Sex of Respondent: 1. Male 2. Famale

Cast/Ethnicity: 1. Hindu 2. Buddhist 3. Muslim 4. Christian 5. Others

Family Type: 1. Single 2. Joint

Roof Type: 1. CGI 2. Stone 3. Khar 4. Others

2. Household Information

2.1 Socio-Economic condition

SN	Name of the Family Member	Sex	Age	Educational Level	Occupation
1					
2					
3					
4					
5					
6					
7					
8					

2.2 Household Assets

2.2.1 Land type and Size

SN	Type of Land	Area (In Ropani)
1	Khet	
2	Bari	
3	Buttyan	
4	Plantation	
5	Others	

2.2.2 Information about livestock

SN	Livestock	Numbers	Quantity of Grain for livestock (Kg/Month)
1	Buffalo		
2	Cow/Ox		
3	Goat/Sheep		
4	Chicken/ Dug		
5	Other		

2.2.3 Household Expenses (Annually)

SN	Heading	Amount in NRs	Remarks
1	Education		
2	Health		
3	Clothes		
4	Energy/ Fuel		
5	Social Activity		
6	Food items		
7	Interest		
8	Others		

2.2.4 Information about agriculture production (crops)

SN	Crops	Farming Area (Ropani)	Production Quantity		Market Value (NRs/Unit)
			Unit	Quantity	
1	Paddy				
2	Maize				
3	Wheat				
4	Mallet				
5	Potato				
6	Soya bean				
7	Mustered				
8	Bean/Mass				
9	Vegetables				
10	Others				

2.2.5 Household Income (Annual in NRs):

SN	Income Sources	Quantity	Unit	Rate	Annual Income(NRs)
Agricultural					
1	Agriculture pro.				
2	Livestock				
3	Vegetables				
4	Others				
Non-Agricultural					
1	Small retail Shop				
2	Cottage industry				
3	Job				
4	Labour				
5	Foreign Job/ Pen				
6	Others				

2.2.6 Have you saving from income?

1. Yes 2. No

If yes, How much amount ……..

3. Energy Supply and Consumption

3.1 Fuel wood collection

SN	Sources	Unit	Quantity
1	Government Forest		
2	Agro-inclusion		
3	Community Forest		
4	Private Forest		
5	Others		

3.2 Quantity of Energy Resources Collection/Supply

SN	Collection/Supply (Per month)	Summer	Winter	Remarks
1	Fuel wood			
2	Agriculture Residue			
3	Animal Dung			
4	Keresene			
5	Coal			
6	LPG			
7	Others			

3.3 Energy Consumption

Consumption period		Fuel wood (Bhari)	Agri Residue (Bhari)	Animal Dung (KG)	Kerosene (Ltr)	LPG (Cyl)	Electricity (KWH)	Others
Summer	Quantity							
	Amount							
Winter	Quantity							
	Amount							

4. Information about Renewable Energy Technology (RET)

4.1 Have you installed Renewable Energy Technology?

1. Yes 2. No

(Note: If Yes, Please fill up the following data)

4.2 Investment for installation of RET

SN	Type of RET	Installation Date	Total Cost	Total Investment		
				Subsidy	Cash	Credit
1						
2						
3						
4						

4.3 Effectiveness of Renewable Energy Technologies

SN	Type of RET	Reason for Installation	Time saving (Hours/day)	Effective*
1				
2				
3				
4				

* 1. Better Education 2. Increase in workload 3. Decrease in workload of woman 4. Health Improve 5.Firewood Saving 6. Decrease in financial load 7.Access in Communication 8. Others

4.4 Information Sources of RET (Please tick mark in sources)

SN	Type of RET	Training	Manual	Relatives	Promoters	Others
1						
2						
3						
4						

4.5 Employment Diversification after the installation of RET.

SN	Activities	Increase	Decrease	Same	Remarks
1	Small Shop				
2	Agro-enterprise				
3	Cottage industry				
4	Labour				
5	Foreign job				
6	Animal Rearing				
7	Chicken Rearing				
8	Others				

4.6 Consumption of Energy Resources before and after the installation of RET

SN	Energy Sources	Before the installation of RET		After the installation of RET	
		Unit	Quantity	Unit	Quantity
1	Fuel Wood				
2	Agri. Residue				
3	Kerosene				
4	LPG				
5	Dry Cell				
6	Others				

4.7 Have you leisure time after the installation of RETs?

1. Yes 2. No

4.8 If yes, in which activities have done in leisure time?

1. Care own self 2. Children care 3. Income Generating (IG) Activities 4. Others

4.9 Satisfaction from the installation of RET.

1. More 2. Medium 3. Not Satisfied

Appendix B: Energy Conversion Tables

Basic Energy Conversion

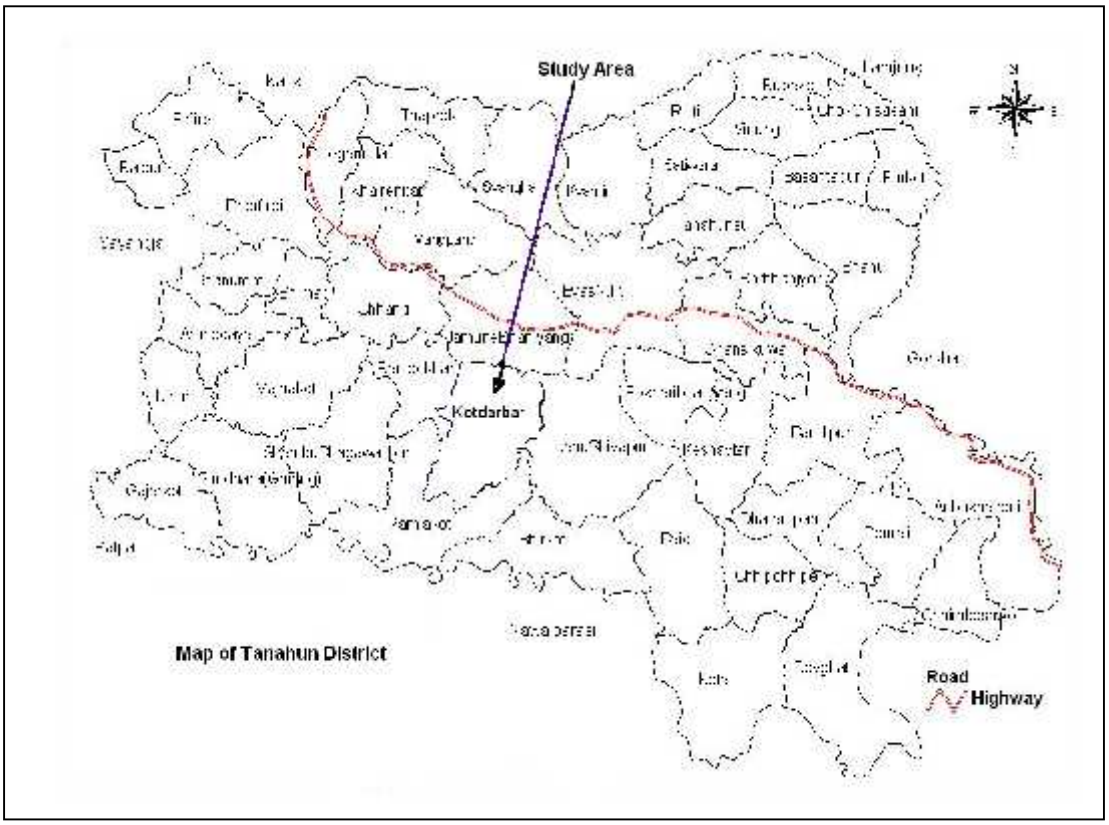
Units	Kcal (000)	GJ	TCE	TOE
Kilo Calori	1.0000	0.0041868	0.0001429	0.0000972
GJ	238.8459	1.0000000	0.0341208	0.0234622
TCE	7000.00	29.3076000	1.0000000	0.0687622
TOE	10290.00	42.6217000	1.4542880	1.0000000

Energy Contents of Various Fuel Type

Fueltype	Unit	Kcal (000)	GJ	TCE	TOE	Other	
Traditional Fuel							
Fuelwood	tonne	4000	16.75	0.57	0.39	1.43	m3
	m3	2800	11.72	0.4	0.27	0.7	tonne
Charcoal	tonne	7100	29.73	1.01	0.69	2.86	m3
	m3	2485	10.4	0.36	0.24	0.35	tonne
Agricultural Waste	tonne	3000	12.56	0.43	0.29		m3
	m3						tonne
Animal Dung*	tonne	2600	10.89	0.37	0.25		m3
	m3						tonne
Biogas	000 m3	5800	23	0.83	0.56		
Commercial Fuel	Unit	Kcal (000)	GJ	TCE	TOE	Others	
Coal	tonne	6000	25.12	0.86	0.58		
	kl		30.08			0.611	tonne
LPG	tonne	11760	49.24	1.68	1.14	1.637	KL
	kl	8000	33.49	1014	0.78	0.71	tonne
MS	tonne	11290	47.27	1.61	1.1	1.41	kl
	kl	8640	36.17	1.23	0.84	0.78	tonne
ATF	tonne	11130	46.60	1.59	1.08	1.29	kl
	kl	8660	36.26	1.24	0.84	0.78	tonne
KRS	tonne	11130	46.06	1.59	1.08	1.29	kl
	kl	9060	37.93	1.29	0.88	0.83	tonne
HSD	tonne	10960	45.89	1.57	1.07	1.21	kl
	kl	9350	39.15	1.34	0.91	0.85	tonne
LDO	tonne	10960	45.89	1.57	1.07	1.17	kl
	kl	9860	41.28	1.41	0.96	0.93	tonne
FO	tonne	10560	44.21	1.51	1.03	1.07	kl
Electricity	MWh	860	3.6	0.12	0.08	5.78	GHh from oil

* dry basis, One tonne of dung yields 190 cubic meter of biogas at 15 degree Centrigrade

Appendix C: Map showing District and VDC



Appendix D: Some Relevant Photographs

Researcher is facilitating community at the time of PRA.

Storage of collected Fuel wood.

Researcher is doing HH Survey.

Focus Group Discussion in ward .

Toilet attached Biogas.

Distribution line of MHP in study area.