Current Energy Consumption in Bhaktapur District

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Abstract: This paper analyze current energy scenario of Bhaktapur district. The survey is done by using the questionnaire in the format recommended by World Bank working paper. Total 91 samples from rural area and 112 samples from urban area are taken. All household consume energy for lighting, cooking and electric appliances. 25% of urban and rural household uses water heating, but in rural, majority 70% of them uses firewood whereas in urban, 75% use LPG for water heating. The use of refrigeration in urban is 53% but is less in rural area i.e. 26%. Similarly 57% of urban household use fan and 39% of rural use fan for space cooling purpose. Urban household has cleaner source of energy whereas rural household consumes more traditional energy. 99% of urban household and 82% of urban household have access to LPG for cooking. Total annual energy consumption of LPG per household is 5.1 gigajoule in urban and 2.9 gigajoule in rural area. In the other hand, 36 gigajoule per household energy is used by traditional cooking stove in rural household and 21 gigajoule per household energy is consumed in urban area for cooking in traditional stove.

Keywords: energy; LEAP; Bhaktapur; energy demand

1. Introduction

Energy plays a pervasive and critically important role in economic and social development. The identification and analysis of energy issue, and the development of energy policy options, are therefore important areas of study by governments, researchers, and the development communities.

Renewables account for nearly half of the increase in global power generation to 2035, with variable sources – wind and solar photovoltaic – making up 45% of the expansion in renewable [1].

In Nepal, total energy consumption in the year 2008/09 was about 9.3 million tonnes of oil equivalent (401 million GJ) out of which 87% were derived from traditional resources, 12% from commercial sources and less than 1% from the alternative sources [2]. On the whole, 70 percent of the households of Nepal have access to electricity in their dwellings. An overwhelming majority of households (96 %) in urban areas have access to electricity in their dwelling while the corresponding figure for rural households is 63 percent. Almost all households in the urban areas of the Kathmandu valley are found to have access to electricity but the corresponding figure is 21 percent for the rural- mid and far western hill areas. Access to electricity in the dwelling is gradually increases from the poorest quintile (42 percent) to the richest quintile (94 percent) [3].

Integrated Energy Planning means analysis of all energy issues within a unified policy framework in order to arrive a set of national optimal energy solution over long term (say, fifteen to twenty years). One of the most crucial outcomes of Integrated Energy Planning has been energy master plan [4].

The energy plan may have visionary objective – to probe into a long term future, in order to access and evaluate the strategies options open to a country in line with its socio-politico-economic policies.

The actual mechanics of the planning process comprise the following steps:

1. Establishing the energy database
2. Building economic growth scenario
3. Making energy demand projections
4. Accessing energy resources
5. Evaluating supply technologies
6. Supply demand balance
7. Carrying out impact analysis
8. Developing investment and other financial plans
9. Framing supply and demand management strategies

Bhaktapur, locally known by Khwopa is world renowned for its elegant art, fabulous culture and indigenous lifestyle. Bhaktapur is filled with monuments, with carved wood columns, palaces and temples with elaborate carvings, gilded roofs, and open courtyards. The city is dotted with pagodas and religious shrines.

Bhaktapur district, located in the eastern part of Kathmandu valley, is the smallest among the seventy-five districts of Nepal, covers an area of 119 km². The

district has sixteen village development committees and two municipalities, Bhaktapur municipality and Madhyapur Thimi Municipality. [5]

The district is small so it has potential to develop as an example district on the field of renewable energies.

2. Methodology

Research methodology is a way to systematically solve research problems [6].

2.1 Problem formulation and literature review

Bhaktapur is the smallest district of Nepal with an area of 119 square km and 1895 person per square kilometer, which is among the highest population density. The district is inside the Kathmandu valley with only 13 km far from Kathmandu, but still many villages of the district is lagging economic development and energy system development compared to other area of Nepal. This district is also having very high and unmanaged urbanization rate. The available energy resources are not been properly utilized. So there is a need of detail study of energy consumption pattern, available resources and detail studies in term of energy planning aspects.

2.2 Questionnaire design

Accurate data on household energy use, combined with other data on household well- being (including consumption, income, health and education), is essential to monitor progress in the household energy transition from traditional biomass fuels to modern fuels and electricity and to evaluate the effect of government energy policies on living conditions. Multitopic socioeconomic household surveys, such as the World Bank's Living Standards Measurement Study (LSMS), can provide data with which to make these measurements [7].

The primary data is collected using questionnaire. The questionnaire is prepared on World Bank format, based on Energy Policies and Multitopic Household Surveys Guidelines for Questionnaire Design in Living Standards Measurement Studies. The questionnaire includes different questions on following topics:

1) General information
2) Fuel source (Biomass and candles)
3) Fuel source (Gaseous and liquid sources)
4) Electricity source (Grid)
5) Electricity source (Off Grid)
6) Durable Goods (Light bulbs and Appliances)
7) Lighting and Cooking Appliances

2.3 Sample size

The sample size can be calculated by using the formula:

$SS = Z^2 (p)(1-p) / c^2$ ……..(1)

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal

(0.5 used for sample size needed)

c = confidence interval, expressed as decimal

And, for finite population,

New SS= SS / (1+(SS-1)/population)[8].

2.4 Field survey

91 data has to be collected from Chhaling V.D.C. This V.D.C. has 9 wards and these numbers of sample are collected from the entire ward and the number of sample from each ward is proportional to the population percentage. Within wards the five samples are taken from one village that is selected randomly.

There are total 17 wards in Madhyapur Thimi Municipality. Sample is taken from each ward with respect to population percentage. So, in total 112 samples are collected from Madhyapur Thimi Municipality.

2.5 Data compilation

The obtained data from 203 households is entered in IBM SPSS statistics. It is an integrated family of products that addresses the entire analytical process, from planning to data collection to analysis, reporting and deployment. Since the questionnaire is long, the SPSS plays vital role for the documentation and analysis of data.

For the analysis of final energy intensity per year of end use devices of household, the LEAP software is used.

Long-range Energy Alternatives Planning (LEAP) is an accounting framework simulation modelling tool developed at the Stockholm Environment Institute (SEI).

3. Results and findings

3.1 Population distribution

The Bhaktapur District has two municipalities and sixteen village development committee. Total population of Bhaktapur district is 303027 and total

household is 73084. Bhaktapur municipality has population of 83893 and Madhyapur Thimi Municipality has total population of 84259. So, total population in urban area is 168152 that is 55 percentage of total population of Bhaktapur district and rest 45 percentage of population live in rural area [9].

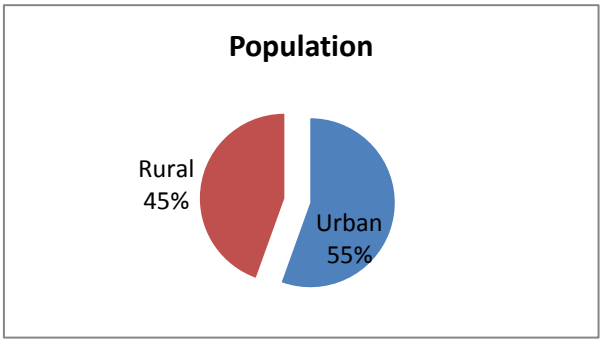

Figure1: Population percentage in rural and urban area

3.2 Present energy scenario

3.2.1 Percentage of access in different types of appliances

The entire households in rural and urban consume energy for cooking, lighting and electric appliances. 25% of urban household and rural household consume energy for water heating. 1% of urban household use LPG for space heating and 9% of rural household consume energy for space heating. The rural household uses the locally available firewood for space heating in winter season around four months. 57% of urban household use fan and 39 % of rural household use fan for space cooling. 53 % of urban household has refrigeration and 26% of rural household has refrigeration. The survey shows that the penetration of energy consuming appliances is higher in urban household than in rural household.

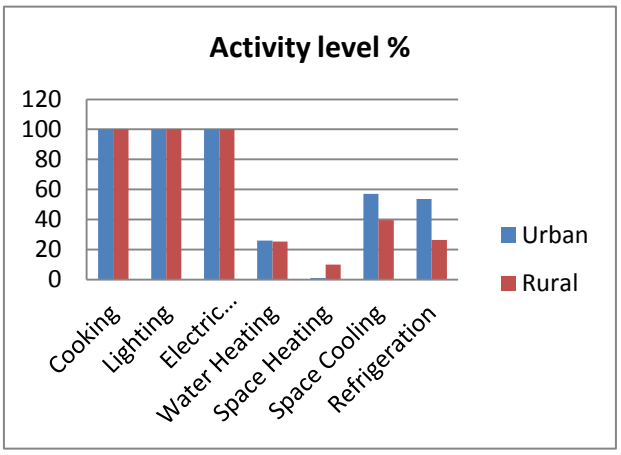

Figure 2: Percentage of penetration of different energy consuming activity of Bhaktapur district

All household of Bhaktapur is connected to national grid of electricity. Majority of household uses CFL and fluorescent lamp. In rural area, incandescent lamp is still used as major lighting appliances. Use of candle and kerosene tuki in load shedding is higher in rural area than urban areas.

Table 1: Percentage of household using different types of lighting

Type of Equipment	VDC	Municipality
CFL	69.24	94.65
Fluorescent	45.06	80.36
LED	5.5	3.58
Incandescent lamp	54.95	28.58
Kerosene tuki	15.39	3.58
Candle	47.26	27.68

Most of the household has LPG for cooking. In rural areas the use of LPG is very less. They use LPG only for making tea or on the arrival of guests. Rural household rely on locally available firewood and agricultural residue for cooking.

Table 2: Percentage of household using different types of cooking

Type of Equipment	VDC	Municipality
LPG	82.42	99.11
Electric Cooker	37.37	30.36
TCS_Firewood	81.32	9.83
TCS_agriresidue	48.36	16.97
Kerosene Stove	2.2	7.15
Microwave oven	0	4.47

The trend of using refrigerator is increasing. More than 50% of urban household uses refrigerator and one fourth of rural household also have access to refrigeration.

Table 3: Percentage of household using refrigeration

Equipment	VDC	Municipality
Refrigerator	26.38	53.58

Fan is used for space cooling purpose. Air conditioning system is not found in household application. Fan is used only for few months in summer.

Table 4: Percentage of household using Space cooling

Type of Equipment	VDC	Municipality
Fan	39.57	57.15

Different types of electric appliances are used in household as shown in table below.

Table 5: Percentage of household using different types of electric appliances

Type of Equipment	VDC	Municipality
Radio	29.68	25.9
DVD	35.17	25
Computer	18.69	42.86
Laptop	19.79	30.36
Iron	58.25	73.22
Pump	19.79	48.22
Music system	2.2	12.5
Mixture grinder	8.8	26.79
Color TV	89.02	89.29
B/W TV	8.8	3.58

25.89% of urban household and 25.27% rural household consume energy for water heating. Among the household that uses water heating, the percentage of household using different fuel sources are shown below.

Table 6: Percentage of household using different types for water heating

	VDC	Municipality
LPG	43.48	75.87
Geyser	8.7	37.94
Firewood	69.57	0
Solar heater	0	13.8

3.2.2 Total energy consumption

The total energy consumption is calculated as the product of an activity level and annual energy intensity (energy used per unit of activity). The total energy consumption is thus calculated by the equation:

Energy consumption= activity level x energy intensity.

Traditional cooking stove is used as major cooking appliances in rural area. Improved cooking stove which has higher efficiency than traditional cooking stove is not found in the entire study area. Local people collect firewood from local forest for cooking purpose in rural area. In urban area the use of firewood is for making alcohol.

Table 7: Final energy intensity (Thousand Mega Joule per household per year) consumed in cooking

	Urban	Rural
LPG Stove	5.1	2.9
Rice Cooker	0.7	0.6
TCS_Firewood	11.2	21.3
TCS_Biomass	10.6	14.6
Kerosene Stove	0	0
ICS	0	0
Induction Cooker	0	0
Microwave oven	0.3	0.3

The final energy intensity of different electric appliances for lighting is given by the product of number of appliances, wattage rating and total hours of operation.

Table 8: Final energy intensity (Mega Joule per household per year) consumed in lighting

	Urban	Rural
Incandescent lamp	258.5	561.7
Fluorescent	750.8	376
CFL	213.9	195.6
LED	19.6	65.7
Kerosene Tuki	108.7	108.7

Different electric appliance is present in household. Among them water pump is used daily basis and has high wattage ratings and thus it has higher final energy intensity. Another electric appliance is computer that has higher operating hours so it also consumes higher amount of energy. Total energy consumption of television is in third place.

Table 9: Final energy intensity (Mega Joule per household per year) consumed by electrical appliances

	Urban	rural
Radio	32.1	31.3
DVD	2.2	2.2
Computer	676.7	632
Laptop	191.3	177.8
Iron	99.2	118.1
Water pump	630.3	631.4
Music System	174.6	216.8
Mixture Grinder	73	165.7
TV	736.9	438.5

4. Conclusion

A survey in the form of questionnaire, of energy consumption patterns in residential households in rural and urban area of Bhaktapur district was undertaken. The status of current energy consumption for heating, cooling, lighting and cooking are investigated. The following results were found.

25% of urban and rural household uses water heating but in rural, majority 70% of them uses firewood whereas in urban, 75% use LPG for water heating.

The use of refrigeration in urban is 53% but is less in rural area i.e. 26%.

57% of urban household use fan and 39% of rural use fan for space cooling purpose.

Urban household has cleaner source of energy whereas rural household consumes more traditional energy.

36 gigajoule per household energy is used by traditional cooking stove in rural household and 21 gigajoule per household energy is consumed in urban area for cooking in traditional stove.

5. Further research area

This paper presents the household energy consumption pattern of rural and urban area of Bhaktapur district. Further research can be carried out to find the energy consumption pattern of other sectors such as transport, industrial sector etc. After developing the database of current energy scenario, the future energy predictions can be done in different scenarios like efficient lighting, replacing traditional cooking stoves by more efficient cooking appliances like induction cooker, using energy star appliances etc.using softwares like LEAP, MARKAL etc.

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