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URBAN HOUSEHOLD ENERGY USE IN NAGALAND

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Abstract

Households depend on energy for various activities like cooking, lighting, heating, cooling, etc. Households in urban areas have a wide diversity of fuels to choose from. However, urban household energy consumption pattern in Nagaland remain poorly understood. The present study therefore aimed to provide a better understanding of households' energy consumption pattern. Stratified random sampling design was used in selecting the households in order to capture the energy consumption patterns across income and household sizes. Data was collected using questionnaire from a total of 510 households. The findings suggested that households use multiple fuel combination, indicating that access to modern fuels did not replace traditional fuels. The per capita consumption of electricity was found to be 25 kilowatt hour per month and that of Liquefied Petroleum Gas (LPG), firewood, charcoal and kerosene was 2.87 kilogram, 22.44 kilogram, 0.06 litre and 0.426 kilogram respectively. It was further revealed that household income have positive impact on electricity and LPG consumption whereas household size is positively related to the consumption of LPG and firewood.

Keywords: Household energy, energy consumption, energy mix

1. Introduction

Energy is a basic resource necessary for existence of life and household is a major consumer of energy. Households depend on energy for activities like cooking, water heating, space heating in colder climates, cooling in hot places, lighting and other electricity end-uses. Energy demand by the households in urban areas is increasing as a result of increasing incomes and improved living standards. Urban households have a wide diversity of fuels to choose from. They have greater accessibility to modern commercial fuels such as Liquefied Petroleum Gas (LPG) and electricity, and energy end-use equipments and appliances. Hence their energy requirements are higher than that of rural residents. Urban households also rely more on commercial energy sources [6]. Therefore with increase urbanization and population over time, urban household energy become an important issue in a developing country like India. Also changing urban lifestyle has great implication in the quantum and pattern of energy use in household residing in these areas [4].

Energy consumption is associated with income. Dash [2] has examined the impact of income on the pattern of household energy consumption and found that the overall energy consumption in the household sector is the highest among high income group than middle and low income groups. Households also gradually move on to modern and efficient fuel with increase in their income levels. This is because price of fuel become less constraint as income increase [7]. However, some studies like Cheng & Urpelainen [1] suggest that increasing access to modern fuel do not replace traditional fuel use. Furthermore, use of traditional fuels in many cities of the developing world continues to remain high especially among low income groups [3].

Urbanisation brings challenges including meeting the growing demand for energy for the household sector. The household sector is responsible for about 45% of total primary energy use in India [7]. In India, 96% of urban households consume electricity, 71% consume LPG, 23% use firewood and chips and 45.7% use

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kerosene. The monthly per capita urban consumption of electricity is 25.8 kWh, whereas those of LPG and firewood are 1.926 kg and 4.29 kg respectively. The monthly per capita urban consumption of charcoal is 0.013 kg while that of kerosene is 0.23 ltr from PDS and 0.166 ltr from other sources. The monthly per capita urban consumption of electricity in Nagaland is 11.203 kWh, 1.969 kg for LPG, 19.629 kg for firewood, 0.063 kg for charcoal and 0.013 ltr for kerosene from PDS and 0.059 ltr from other sources. The major energy items such as electricity, firewood, kerosene and LPG accounted for 95% of energy consumption in urban India [5].

2. Objective

This paper aims to understand the households' energy consumption pattern and the relationship between household energy choices with income and household sizes.

3. Database and Methodology

The study is confined to the urban municipal areas of Kohima and Dimapur districts, the two being the largest cities in Nagaland. Kohima city has a total population of 99,039 and 22,312 households as per the 2011 census. It is divided into 19 wards. On the other hand, Dimapur city has a total population of 122,834 and 27,165 households, and is divided into 23 wards. The study is based on primary data which have been collected through sample survey, using questionnaire method. Stratified random sampling technique was used to select the respondents, where 40% of the wards in each city and 30 households from each selected ward, i.e., 240 households from 8 wards in Kohima and 270 households from 9 wards in Dimapur were selected for the study. Data were analysed using descriptive statistical tools and regression analysis.

A multiple regression model has been applied in analysing the relationships between various types of household energy choices with the determining variables:

$$E_c = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

Where: E_c is household energy consumption, α is the intercept of E_c, B_1 and B_2 are regression coefficients, X_1 and X_2 are the independent variables viz., household income and household size respectively, and ε represents error term.

4. Results and Discussion of the study

4.1. Profile of respondents: The sample profile of the study is summarised in table 1. The sample consists of 510 households, comprising both female-headed households (19%) and male-headed households (81%). Female constitutes 48.6% and male 51.4% of respondents in the study. Households are categorised into small (29.4%), medium (65.3%) and large (5.3%) sizes. By age, it was found that 55.5% of households' heads are more than 50 years of age, 38.8% are of age group 31-50 years and that of 16-30 years comprised 5.7%. Among the sampled households, 65.9% live in their own houses whereas 29.2% live in rent and 4.9% in official quarters. By income distribution, 12.2% of the sampled households belong to low income group, 49% belong to medium income and 38.8% are in high income group.

Table 1: Sample profile

Characteristic	**Frequency**	**Percent**
Gender of respondent		
Female	248	48.6
Male	262	51.4
Respondents		
Household head	240	47.06
Not household head	270	52.94
Gender of household head		
Female-headed	97	19
Male-headed	413	81
Household size		
Small (1-3 members)	150	29.4
Medium (4-7 members)	333	65.3
Large (>7 members)	27	5.3

Age of household head		
16-30 years	29	5.7
31-50 years	198	38.8
>50 years	283	55.5
Educational qualification of household head		
No schooling	22	4.4
Primary	46	9
High school	97	19
Secondary	93	18.2
Graduate	179	35.1
Post graduate	73	14.3
Occupation status of household head		
Student	14	2.8
Retired	86	16.9
Self-employed	62	12.2
Govt. Service	220	43.1
Private service	71	13.9
NGO worker	3	0.6
Unemployed	31	6.1
Full-time stay-at-home parent	23	4.5
Dwelling ownership		
Owned	336	65.9
Rented	149	29.2
Quarters	25	4.9
Household income group		
Low (<Rs. 20,000)	62	12.2
Medium (Rs. 20,000-Rs. 50,000)	250	49
High (>Rs, 50,000)	198	38.8

4.2. Household energy consumption pattern in the study area: The findings revealed that households use multiple energy choices for cooking, lighting, heating, cooling and other activities. The various sources of household energy are electricity, LPG, firewood, kerosene, charcoal, and solar. All the sampled households have access to electricity and LPG, while 60% of the households use firewood, 15.88% use charcoal, 5.88% use kerosene and 34.12% of the households are found to have solar devices. It can be seen from table 2 that households in Kohima use more firewood and charcoal than those in Dimapur as the former is a much cooler place and hence these fuels are used frequently for heating purposes compared to the later. Electricity, LPG and firewood are the dominant fuels used by majority of the households as shown in Fig. 1. The traditional fuel i.e., firewood is still used by a large number of households in the urban areas as the people are habituated to its use and because of its easy availability and accessibility to the source.

Table 2: Percentage of households using various energy sources in the study area

	No. of households	Electricity	LPG	Firewood	Kerosene	Charcoal	Solar
Kohima	240	100	100	72.50	8.75	32.92	54.4
Dimapur	270	100	100	48.89	3.33	0.74	13.7
Overall	510	100	100	60	5.88	15.88	34.12

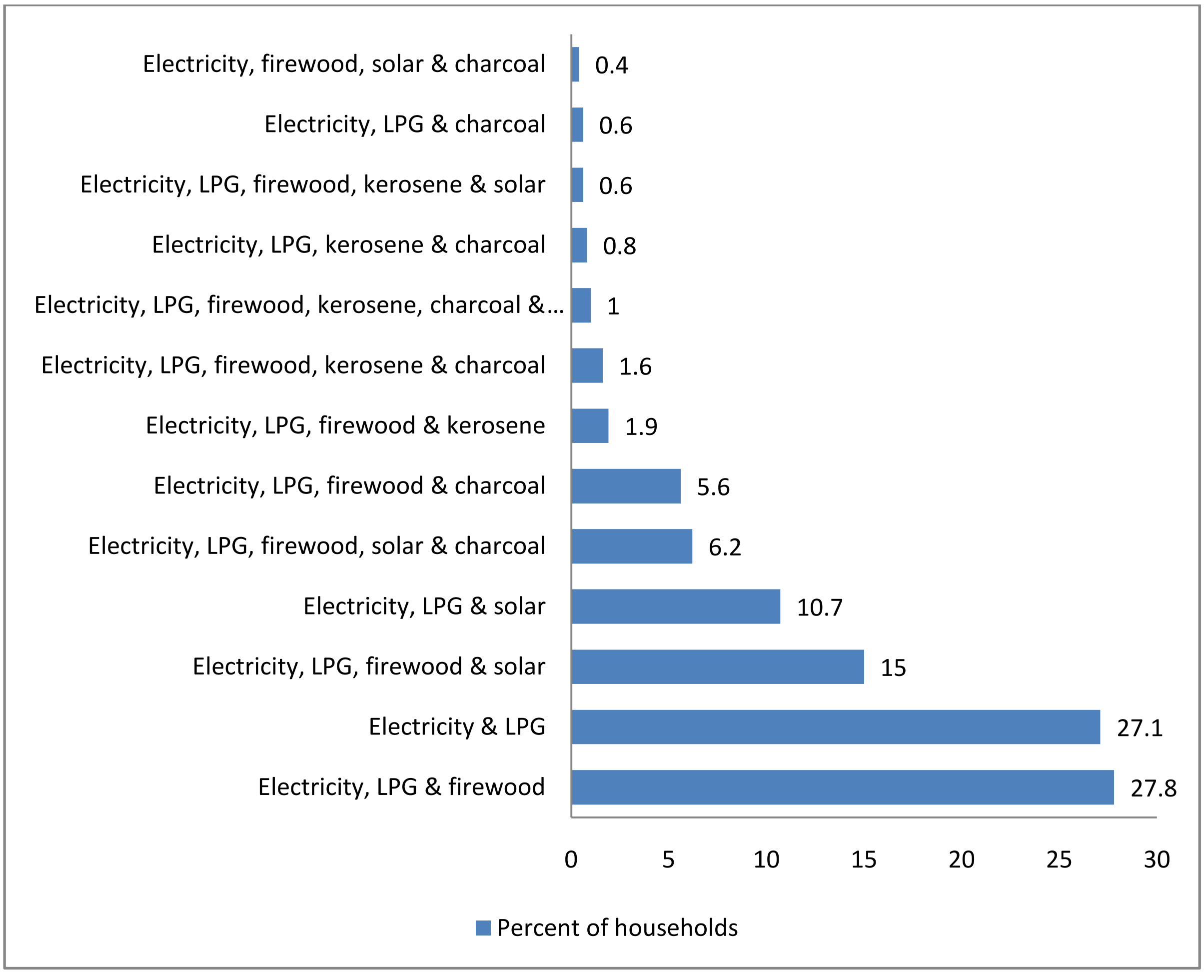
Source: Field survey 2016-17

Table 3: Energy consumption in the sampled households

Energy type	Energy consumption per month	Per capita consumption
Electricity	13511 kWh	25 kWh
LPG	6882.27 kg	2.87 kg
Firewood	53790 kg	22.44 kg
Kerosene	143 ltr	0.060 ltr
Charcoal	1021.5 kg	0.426 kg

Source: Field survey 2016-17

Fig. 1: Households' fuel consumption in the study area.



Source: Field survey 2016-17

It can be seen from table 3 that the monthly average electricity consumption in the study area was 13511 kWh with per capita consumption of 25 kWh. The monthly consumption of LPG was 6882.27 kg and that of firewood was 53790 kg with per capita consumption of 2.87 kg and 22.44 kg respectively. Kerosene and charcoal consumption was 143 ltr and 1021.5 kg per month respectively with per capita consumption of 0.060 ltr for kerosene and 0.426 kg for charcoal.

Table 4 shows the relationship between household energy use and income. It can be seen that high-income households are the highest users of electricity, LPG and firewood combination (36.36%), followed by middle-income (23.60%) and low-income households (19.35%). Whereas, middle-income are more likely to use the combination of electricity and LPG (38%) compared to the other income groups. Likewise, 15.15% of the high-income households use the combination of electricity, LPG, firewood and solar in their homes.

Table 4: Relationship between household energy consumption and income

Household energy combination	**Household income group**			**Total**
	Low	**Medium**	**High**	
Electricity, LPG & firewood	12 (19.35)	59 (23.60)	72 (36.36)	143
Electricity & LPG	18 (29.03)	95 (38.00)	26 (13.13)	139
Electricity, LPG, firewood & solar	8 (12.90)	39 (15.60)	30 (15.15)	77
Electricity, LPG & solar	7 (11.29)	21 (8.40)	27 (13.64)	55
Electricity, LPG, firewood, solar & charcoal	3 (4.84)	18 (7.20)	11 (5.56)	32
Electricity, LPG, firewood & charcoal	1 (1.61)	13 (5.20)	15 (7.58)	29
Electricity, LPG, firewood & kerosene	2 (3.23)	2 (0.80)	6 (3.03)	10
Electricity, LPG, firewood, kerosene & charcoal	4 (6.45)	0 (0)	4 (2.02)	8

Electricity, LPG, firewood, kerosene, charcoal & solar	1 (1.61)	2 (0.80)	2 (1.01)	5
Electricity, LPG, kerosene & charcoal	4 (6.45)	0 (0)	0 (0)	4
Electricity, LPG, firewood, kerosene & solar	0 (0)	1 (0.40)	2(1.01)	3
Electricity, LPG & charcoal	2 (3.23)	0 (0)	1 (0.51)	3
Electricity, firewood, solar & charcoal	0 (0)	0 (0)	2 (1.01)	2
Total	62	250	198	510

Source: Field survey 2016-17

**Figures in the parentheses indicate percentages*

The relationship between household energy consumption and household size in Table 5 shows that small-sized families are more likely to use the electricity and LPG combination (57.33%) whereas medium-sized families dominate in the use of energy mixture of electricity, LPG and firewood (32.33%). On the other hand, large-sized families are more likely to use the energy combination of electricity, LPG, firewood and solar (25.93%).

Table 5: Relationship between household energy consumption and household size

Household energy combination	**Household size**			**Total**
	1	**2**	**3**	
Electricity, LPG & firewood	29 (19.33)	108(32.43)	6 (22.22)	143
Electricity & LPG	86 (57.33)	47 (14.11)	6 (22.22)	139
Electricity, LPG, firewood & solar	7 (4.67)	63 (18.92)	7 (25.93)	77
Electricity, LPG & solar	17 (11.33)	34 (10.21)	0 (0)	55
Electricity, LPG, firewood, solar & charcoal	2 (1.33)	26 (7.81)	4 (14.81)	32
Electricity, LPG, firewood & charcoal	0 (0)	28 (8.41)	1 (3.70)	29
Electricity, LPG, firewood & kerosene	0 (0)	9 (2.70)	1 (3.70)	10
Electricity, LPG, firewood, kerosene & charcoal	2 (1.33)	6 (1.80)	0 (0)	8
Electricity, LPG, firewood, kerosene, charcoal & solar	1 (0.67)	4 (1.20)	0 (0)	5
Electricity, LPG, kerosene & charcoal	4 (2.67)	0 (0)	0 (0)	4
Electricity, LPG, firewood, kerosene & solar	0 (0)	1 (0.30)	2 (7.41)	3
Electricity, LPG & charcoal	2 (1.33)	1 (0.30)	0 (0)	3
Electricity, firewood, solar & charcoal	0 (0)	2 (0.60)	0 (0)	2
Total	150	333	27	510

Source: Field survey 2016-17

**Figures in the parentheses indicate percentages*

4.3. Relationship between energy choices and household size: The relationship between various energy choices and household size is shown in Table 6. All the households have access to electricity and LPG, while 77.78% of large-sized households, 73.27% of medium-sized and 27.33% of small-sized households consume firewood which clearly indicates that large households use firewood more in their homes as compared to smaller ones. Similarly, larger sized households are found to consume kerosene and charcoal more than their lower counterparts.

Table 6: Relationship between household size and energy choices

Household size	**Frequency**	**No. of households using**				
		Electricity	**LPG**	**Firewood**	**Kerosene**	**Charcoal**
Small	150 (29.4)	150 (100)	150 (100)	41 (27.33)	7 (4.67)	11 (7.33)
Medium	333 (65.3)	333 (100)	333 (100)	244 (73.27)	20 (6.01)	62 (18.62)
Large	27 (5.3)	27 (100)	27 (100)	21 (77.78)	3 (11.11)	8 (29.63)

Source: Field survey 2016-17

**Figures in the parentheses indicate percentages*

4.4. Relationship between energy choices and household income: The relationship between household income and energy choices in table 7 reveals that higher income households use firewood more than their lower counterparts. However, in the case of kerosene the low income group is found to be using the most (17.74%), followed by high income group (6.57%) and middle income group form the least kerosene-consuming households. Similarly, low income group consume charcoal the most (24%) compared to middle income (12.4%) and high income (17.68%) groups.

Table 7: Relationship between household income and energy choices

Household income (Rs)	**Frequency**	**No. of households using**				
		Electricity	**LPG**	**Firewood**	**Kerosene**	**Charcoal**
<20,000	62 (12.2)	62 (100)	62 (100)	31 (50)	11 (17.74)	15 (24.19)
20,000-50,000	250 (49)	250 (100)	250 (100)	132 (52.8)	6 (2.4)	31 (12.4)
>50,000	198 (38.82)	198 (100)	198 (100)	143 (72.22)	13 (6.57)	35 (17.68)

Source: Field survey 2016-17

**Figures in the parentheses indicate percentages*

4.5. Regression Analysis: Regression results shows that household income have positive impact on electricity and LPG consumption and are statistically significant at 1%. This indicates that as households' monthly income increases by Rs. 1000, electricity consumption increase by 4.449 kWh and that of LPG consumption increase by 0.70 Kg. Similarly, household size is found to be positively related to LPG and firewood consumption but negatively related to electricity consumption and is statistically significant at 1% level. That is, for every one person increase in household member, electricity consumption decreases by 3.95 kWh, and LPG and firewood consumption increase by 0.74 kg and 24.15 kg respectively. However, household income has no significant effect on firewood consumption. The impact of household size on kerosene consumption is negative (-1.14 litres), which is significant at 5%. On the other hand, the independent variables are not significantly related to charcoal consumption. The R^2 value 0.20 for electricity means that 20% of the variation in electricity consumption is explained by household size and income. Likewise, the low values of R^2 in case of LPG (0.10), firewood (0.05), kerosene (0.13) and charcoal (0.02) indicates that factors other than household size and income have greater influence on the household energy consumption.

Table 8: Regression results of household energy consumption with household size and income

Energy choice	**Variables**	**Coefficients**	**N**	**R^2**	**F**
Electricity (in kWh)	Constant Household income Household size	34.395 4.449 (6.36)* -3.952 (10.76)*	510	0.20	63.56
LPG (in kg)	Constant Household income Household size	8.328 0.696 (2.89)* 0.741 (5.85)*	510	0.10	28.70
Firewood (in kg)	Constant Household income Household size	-30.290 9.213 (0.97) 24.146 (4.82)*	306	0.05	14.71
Kerosene (in ltr)	Constant Household income Household size	5.813 2.005 (1.85) -1.145 (1.74)**	30	0.13	1.96
Charcoal (in kg)	Constant Household income Household size	9.719 -0.142 (0.164) 0.625 (1.04)	80	0.02	0.69

Figures in parenthesis indicate t-values.

**Statistically significant at 1%*

*** Statistically significant at* 5%

5. Conclusion

The findings revealed that households use a combination of fuels- both traditional and modern fuels for various purposes. The results of the descriptive analysis show that five types of energy are used by the urban households in Nagaland, these include; electricity, LPG, firewood, kerosene and charcoal. Electricity, LPG and firewood are the dominant energy choices used by the urban households. The study found that a high percentage of households continue to cook and heat their home with traditional fuel like firewood along with modern fuels, despite it being an inefficient energy source. An important reason for this can be attributed to households' easy accessibility to firewood from surrounding rural areas and availability from local markets. This could have profound and long lasting negative effect to the forests and on the health of the households.

The demand for fuel will continue to increase as more people move in to the urban areas. Therefore, meeting the growing demand of energy in the household sector will be a challenge.

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