A Study on Domestic Energy Consumption in Rural, Semi-urban, and Urban Sectors of Jorhat District: Assam

Reeta Sarma*, M.C. Bora, and D.J. Bhattacharyee*****

* Mechanical Engineering Department, Jorhat Engineering College, Jorhat - 785 007, Assam, INDIA

** Department of Business Administration, Tezpur University Tezpur, Assam, INDIA

*** Mechanical Engineering Department, Assam Engineering College Guwahati, Assam INDIA

ABSTRACT

The energy consumption pattern of rural, semi-urban and urban domestic sectors of Jorhat district of Assam was examined. Rural sector was so chosen that 100% of the households used fuelwood as cooking fuel and kerosene as space lighting fuel. The per capita fuelwood consumption was found to be 8.531 GJ/year and that of kerosene per capita was found to be 0.270 GJ/year. In semi-urban sector, the households used fuelwood and LPG as cooking fuels with kerosene and electricity as space lighting fuels. The per capita consumption of fuelwood in this sector was found to be 0.682 GJ/year while the kerosene per capita was estimated as 0.278 GJ/year. In the urban households, consumption per capita was estimated as: LPG 1.903 GJ/year, kerosene 0.332 GJ/year and electricity 0.623 GJ/year. The urban households used LPG and kerosene as cooking fuels with electricity and kerosene as space fuels.

1. INTRODUCTION

Like most developing countries, domestic consumption of fuel has a larger share in the national energy consumption in India. Despite the availability of the commercial sources of energy such as electricity, petroleum, oil, diesel, LPG, coal and introduction of new and renewable sources; the non-commercial and traditional sources of energy namely, fuelwood, dung and agricultural wastes still constitute the main sources of domestic energy in rural India catering to the needs of about 86% of rural households [1]. Of these traditional sources, fuelwood occupies a pre-eminent position catering to 56% of the rural households [2]. Besides, fuelwood also satisfies the energy needs of more than 30% of urban households [3-5].

With varied physical and socio-economic scenarios, the energy situations in India have been diverse in nature which calls for a wide range of solutions [6]. As such, special understanding appears to be a basic approach towards evolving area-specific rural energy strategies [7].

In Assam, which is situated in the north-easthern part of India, majority of the rural people rely primarily on woodfuels collected from nearby forests or fields as cooking fuel and on kerosene as domestic lighting fuel, since electricity is very poor in rural areas. Consequent upon the large scale

consumption of fuelwood is the rapid depletion of forest resources. Though rice is the main crop in Assam, a huge amount of rice residues go to waste due to lack of awareness of rural mass about the proper utilization of these as domestic fuels. Six un-electrified villages were sampled on the bank of river Brahmaputra in Jorhat district of Assam purposely to study the domestic energy consumption pattern. Total mass do not buy wicks for wick lamps as they buy for hurricane lamps. They use waste cloth fiber as wick in lamps as they find it easily available in their houses.

The semi-urban people use fuelwood, kerosene and LPG as cooking fuels with kerosene and electricity as lighting fuels. They purchase fuelwoods from the market that come from the rural areas. As electricity failure is regular in this area, almost all people have to keep kerosene as alternative for domestic lighting. Fuelwood and LPG agencies are from the town agencies. Transportation problems are the major problems faced by semi-urban mass in carrying LPG cylinders as no home service arrangements are available.

The urban people of Assam mainly use LPG and kerosene for cooking, with kerosene and electricity for lighting purposes. Besides lighting, the urban mass uses electricity to run some household electrical appliances. They also keep kerosene in stock as alternative energy source for lighting when electricity fails.

As not much studies have been conducted in the line of domestic energy consumption in the north-eastern part of India, [4, 8] this paper attempts to present an analysis on domestic energy consumption in rural, semi-urban and urban sector of Jorhat district of Assam.

2. MATERIALS AND METHODS

The study was based on sample survey. A stratified random sampling technique was used for selecting households as sample units. The three sectors were identified based on infrastructural facilities like condition of roads, availability of electricity, transportation, civic amenities like post office, bank, co-operative society, marketing facilities, LPG agencies, educational facilities, medical facilities etc. Based on the existing facilities and distance required to traverse to avail these facilities, the three sectors were identified in which 0-5 km represents urban, > 5 km represent semi-urban and > 10 km represents rural sectors. Sample of 458 households were chosen for rural households, 205 for semi-urban households and 225 for urban households.

The domestic energy consumption and patterns were obtained from every household through a questionnaire. The survey data were collected at two levels - the sector and the household. Table 1 lists the parameters on which information was sought. The data were collected by personal interview. Data were collected from all the households (458 households in rural sector, 205 households in semi-urban sector and 225 households in urban sector). Approximately 30 min. time was taken in filling up the information schedule for each household.

The domestic energy demand for two end uses were considered, mainly for cooking and lighting. The information on cooking from the questionnaire was on the type of fuel and amount consumed per day per household. Data regarding consumption of fuelwood and kerosene per day per household and unit of electricity consumption per month per household were collected from the sampled families. Based on the feed back received, the data were modified to standard forms. These fuels were grouped into firewood, kerosene, LPG and electricity against the three sectors, i.e. urban, semi-urban and rural.

The amount of fuel consumed in one day was multiplied by its calorific value to find the daily energy consumption. Calorific values of different types of fuels used in the three sectors were taken from [5, 9]. The calorific value of fuelwood with 20% moisture content (air-dried) is 15 MJ/kg and

Table 1 Information Items Covered in the Survey

Sector schedule • Location of the sector • General characteristics – distance from the central town, infrastructural facilities, etc. • Demographic characteristics – population, number of households, etc. • Types of domestic fuels • Types of end uses • Sources of fuels
Household schedule • Domestic energy consumption – consumption of fuelwood (both in summer and winter), kerosene, LPG and electricity for different end uses such as cooking, water-heating, space heating and space lighting. • Cooking stove particulars – type of stoves, number of hours spent in cooking. • Space lighting particulars – type of appliances, consumption

that of kerosene is 44 MJ/kg. Also calorific value of LPG is 44 MJ/kg (35.2 MJ/m^3). 1 kW-hr of electricity is equivalent to 3.6 MJ.

The energy consumed per day was converted into the annual energy consumption. Extra 40% of the daily fuelwood consumption was added for winter season (November to February) in the calculation of annual consumption rate because most of the rural households keep extra arrangement to burn low quality bio-fuels for warming up. The energy consumption in a household was added to obtain annual energy consumption rate of a sector.

LPG serves as cooking fuel in semi-urban and urban sectors. Data on number of cylinders required in a month per household were obtained and converted into energy. One LPG cylinder for domestic use contains 14.2 kg of fuel and this converts to 624.8 MJ of energy. The consumption of energy per household per month was multiplied by 12 to find the annual energy consumption of LPG in cooking. The energy consumption of households in a sector was added to obtain annual energy consumption rate of a sector.

Kerosene is the second source of energy used for lighting in rural domestic sector. As sampled rural areas were totally un-electrified, 100% of rural households depend on kerosene for space lighting. In semi-urban sector, average electricity failure usually occurs for 6 hours per day and that in urban sector for two hours per day. For this reason, the semi-urban and urban and urban people keep kerosene as alternative for lighting their houses. Some of urban households use kerosene for cooking also. Daily consumption of kerosene per household was obtained in volumetric measurements in the three study sectors and those were converted to weight (1 liter of kerosene = 0.8 kg). The daily consumption of kerosene in kg per household has been multiplied by 365 days to find the annual consumption. Finally, the sum of energy consumption for the three sectors was taken.

Data regarding average unit consumption of electricity in kWh per month in the households of semi-urban and urban sectors were collected. These data collected were converted to MJ (1 kw-hr = 3.6 MJ) and then multiplied by 12 to obtain annual electricity consumption per household. When added for total households, the pattern of annual electricity consumption was obtained for each sector.

3. RESULTS AND DISCUSSIONS

3.1 Rural Domestic Sector

Table 2 shows the data on per capita per year domestic energy consumptions in rural, semi-urban and urban sectors. 100% of rural households rely on fuelwood as their cooking fuel and kerosene as lighting fuel. Fuelwoods in the form of twigs, fallen branches, bamboo and other low quality fuels are used in cooking. The annual energy consumption in the form of fuelwood for cooking was estimated for villages under study to be 50 831.26 GJ and per capita per year consumption to be 8.531 GJ. The annual energy consumption from kerosene was to be 1606.53 GJ and capita per year consumption was estimated as 0.270 GJ. Wick and hurricane lamps were found to be the lighting appliances in the sampled villages. Kerosene is rationed on the basis of size of family. The rural people do not buy wicks for wick lamps as they buy for hurricane lamps. They use waste cloth fiber as wick for the wick lamps.

Table 2. Comparison of Energy Consumption in Domestic Sectors for Rural, Semi-rural and Urban Sectors of Jorhat District, Assam

Sl. No.	Item	Rural	Semi-urban	Urban
1	Distance from Jorhat town	> 10 km	< 5 km	0 – 5 km
2	Population	5954	1640	1350
3	Use of kerosene	1606.53 GJ/year (0.270 GJ/capita/year)	565.80 GJ/year (0.345 GJ/capita/year)	448.20 GJ/year (0.332 GJ/capita/year)
4	Use of fuelwood	50831.26 GJ/year (8.531 GJ/capita/year)	1118.48 GJ/year (0.682 GJ/capita/year)	Nil
5	Use of LPG	Nil	2399.32 GJ/year (1.463 GJ/capita/year)	2569.05 GJ/year (1.903 GJ/capita/year)
6	Use of electricity	Nil	455.92 GJ/year (0.278 GJ/capita/year)	841.05 GJ/year (0.623 GJ/capita/year)

3.2 Semi-urban Domestic Sector

In semi-urban sector, the annual fuelwood consumption in cooking has been estimated at 1118.48 GJ and per capita per year consumption has been 0.682 GJ. About 35% of semi-urban residents use fuelwood as their cooking fuel with some households keep fuelwood as one of the alternatives for cooking when there is a shortage of LPG supply or delay in LPG collection due to transportation problems. The people of this sector purchase fuelwood from the market supplied from the rural sector or directly from the rural people.

Majority of the people from semi-urban sector prefer LPG as cooking fuel and buy LPG cylinders from local agencies or from central town agencies. They face transportation problem in collecting LPG cylinder from the town. The annual LPG consumption in this sector was found to be 2399.22 GJ and per capita per year consumption was estimated at 1.463 GJ.

The semi-urban sector is mostly electrified, and thus electricity is the main lighting source. Also electricity is used in some households to run TV. However, the people do keep kerosene in stock (procured from family rationed system) as lighting alternative during major and regular electricity failure (average 6 hours per day) in this sector. The annual kerosene consumption is estimated at 565.80 GJ and per capita per year consumption at 0.345 GJ. The annual electricity consumption is around 455.92 GJ and per capita per year consumption is 0.278 GJ.

3.3 Urban Domestic Sector

In general the urban people do not use fuelwood as cooking fuel. Instead they use LPG as their prime cooking fuel. In some urban households kerosene stoves are used for water heating. They buy LPG cylinders from the agencies. Home delivery of LPG cylinders is available. The annual LPG consumption is around 2569.05 GJ and per capita per year consumption was found to be 1.903 GJ in the sampled households.

This sector is totally electrified. Electricity is the main lighting component. Besides lighting, electrical appliances like oven, heater, press (iron), grinder, TV etc. are used in urban households. Electricity failure varied every day. Therefore based on the data and information collected an allowance of average two hours electricity failure per day has been considered. Annual electricity consumption was estimated at 841.05 GJ and per capita per year consumption was found to be 0.632 GJ. The kerosene consumption was found to be 448.20 GJ/Year and per capita per year consumption was estimated as 0.332 GJ.

Figure 1 shows the bar diagram of domestic energy consumption of different fuels in GJ/Capita/year in three different study sectors.

3.4 Test of Variations

The major hypothesis to be tested in the study is to find significant variations, if any, of fuel consumption in between and within the treatment, i.e. sectors. To test the hypothesis, analysis of variance (ANOVA) e.g. F-test was employed. Table 3 shows one way ANOVA table with unequal sample size on domestic energy consumption in the selected rural, semi-urban and urban sectors of Jorhat district of Assam. The per capita consumption of each type of domestic fuel was taken for three

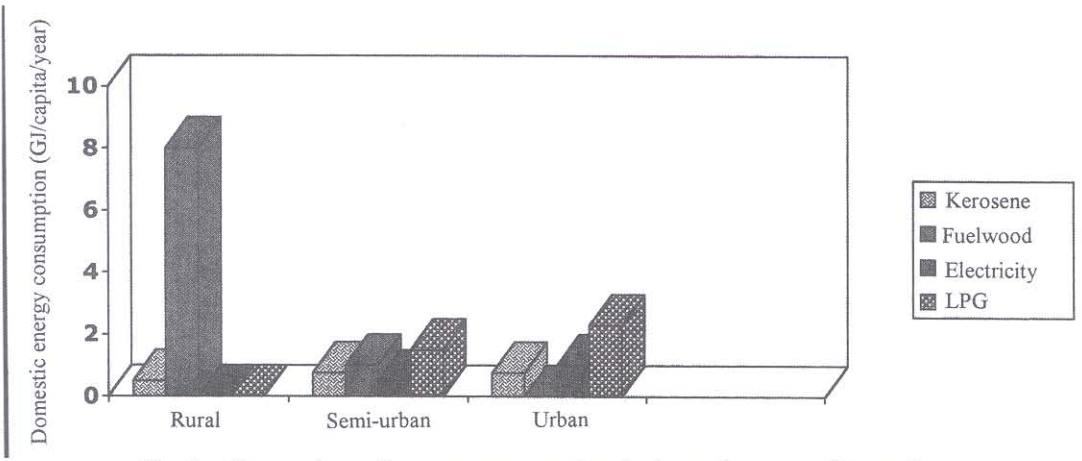

Fig. 1. Comparison of energy consumption in domestic sectors for rural, semi-rural, and urban sectors of Jorhat district, Assam.

sectors. The F-ratio is calculated for different fuels as shown in Table 3. The calculated F-values in case of all the fuels are higher than the table values of F which are 4.74 and 4.46 for fuelwood and LPG respectively at 5% level of significance. On the other hand, table values of F are 6.70 and 8.02 for kerosene and electricity respectively at 1% level of significance. Hence, the null hypothesis is rejected which means that the consumptions of domestic energy have high significant variations in between and within the sectors.

Fire wood has a significant variations among the sectors. It clearly indicates that with development, determined by the availability of infrastructural facilities, the use of firewood goes down in the semi-urban sector and is nil in urban sector.

LPG has also a significant variations among the sectors indicating that with increasing infrastructural facilities, the use of LPG goes up in urban sector first then in semi-urban sector and the rural sector do not at all use LPG in cooking.

The variation in the use of kerosene is found to be highly significant in between and within the sectors, where F-ratio is estimated as 67.71. It reveals that with the increase in distance for infrastructural facilities, there is an adverse condition in electricity position. Electricity is available mostly in urban sector with average two hours of failure per day, in semi-urban sector with average six hours of failure per day for which use of kerosene is another alternative for domestic lighting in those two sectors. As most of the rural sector is completely un-electrified, use of kerosene is a must for domestic lighting. Hence, the variation in the use of electricity among the three sectors is estimated to be significant with F-ratio of 8.95.

Table 3 One Way ANOVA Table with Unequal Sample Size on Domestic Energy Consumption in Rural, Semi-Rural and Urban Sectors of Jorhat-District, Assam

Types of fuel	Source of variation	Sum of square	Degree of freedom	Mean square	Calculated "F"	Table value of "F"	Acceptance/ Rejection of hypothesis	Level of significance
Fuelwood	BT	7134.71	2	2218.15	6.99	4.74	Rejected	0.05
	WT	2218.15	7	316.88				
Kerosene	BT	101.25	2	50.63	67.71	6.70	Rejected	0.01
	WT	9.72	13	0.75				
LPG	BT	49.26	2	24.63	6.57	4.46	Rejected	0.05
	WT	29.99	8	3.75				
Electricity	BT	14.39	2	7.20	8.95	8.02	Rejected	0.01
	WT	7.34	9	0.82				

BT = Between Treatment
WT = Within Treatment

4. CONCLUSIONS

A wide variation of the types of energy sources used for domestic consumption in rural, semi-urban sectors of Jorhat district of Assam is evident from statistical analysis. Though production of agricultural residues and animal dung are found in abundance in rural areas, these are not used due to availability of free forest fuel and due to lack of technology of using the wastes. So, stress should be given to employ appropriate technology for proper utilization of agricultural wastes and dung minimizing fuelwood use. This might be helpful in checking deforestation and upgrading of environment and quality of rural life. Urban sector depends entirely on commercial fuels. The scope of installing new and renewable technology is more promising due to better level of educational and awareness among urban mass. Hence, there is ample scope for energy conservation through appropriate use of untapped energy sources available in the rural area in the form of agricultural wastes. It is necessary to initiate studies to estimate the domestic energy use in different regions and potential for efficiency improvements to formulate effective energy policy in near future.

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