

Disparities in Pattern of Household Energy Use: A Study of Rural and Urban India

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Abstract: There exists a disparity in the pattern of household energy use between rural and urban areas in India which makes its comparative analysis an interesting proposition, not only by itself but also from policy perspective, and this is the focus of this paper. The study uses the secondary data of Census 2001 and 2011, National Sample Survey Office (NSSO) 2013 and 2014, Ministry of Statistics and Programme Implementation (MOSPI) and The Energy and Resources Institute (TERI) 2013 and 2014. The study found electricity as the primary source of energy used for lighting in both rural and urban areas while biomass as the dominant energy used in rural areas as against the use of Liquefied petroleum Gas (LPG) or Piped Natural Gas (PNG) in urban areas for cooking purposes. While analysing the decadal change in the rural and urban household energy use during the period 2001 to 2011, the study found that the households were shifting from kerosene to electricity and biomass to LPG/PNG for lighting and cooking purposes in urban and rural areas respectively.

JEL Classification Codes: D63, K32, R2, O18

Keywords: Disparities, energy, household, rural, urban

I. INTRODUCTION

Energy is vital for the development of human beings, their standard of living and economic growth of the countries as it is one of the major factors of economic development. Demand for energy in the present time period is continuously increasing because of industrialisation, urbanisation and modernisation and because everybody wants a comfortable and healthier life. So, production of energy should be increased to meet this continuously increasing energy use which may be unfeasible by the current availability of energy sources in our country. Further various studies have found that

India will be the third largest energy consuming country in the World by 2035(International energy agency, 2021). So, the Government should prepare proper policies for increasing the production of nuclear power and renewable sources of energy which will not only meet the increased energy demand but also help to have sustained and self-sufficient energy sources for the future generation

Energy use in a country basically implies use of energy in the agricultural sector, industrial sector, transport sector and household sector. So, development of an economy mainly depends on the energy sector as it is one of the key instruments for the development of all the sectors. Thus, to have a sustained economic development, production of energy should be more than the consumption of energy which can be possible by the proper strategies of the Government.

Out of all the sectors of an economy household sector is one of the most important sectors as a major portion of the energy is used in this sector for various household purposes particularly for lighting and cooking as compared to other sectors. A country can achieve economic development as a whole only when there is equal accessibility of energy to all. But in developing countries like India, a large part of the energy is utilized for the process of industrialisation and modernization in cities than rural areas resulting in less availability of energy as compared to its demand. Further the type of energy used by the rural households from the available energy sources, restrained by low level of income, lack of accessibility of modern fuels, various energy tools and devices which forces them to be dependent more on traditional sources of energy. Contrary to this households of urban area having extensive choices of are switching towards use of modern sources of energy than traditional one. Hence rural-urban dissimilarity can be observed in the sources of energy used for various household purposes. So, economic development can be achieved by solving the problem of rural-urban energy use disparity which requires proper planning for making available modern energy sources equally accessible to all areas. This requires proper understanding of disparities in rural-urban energy use for which this paper focuses on the detail analysis of differences in the rural-urban household energy use specifically for cooking and lighting as most of the energy in the household sector is utilized for these two purposes.

Objective of the Study

The objective of the present study is to explore the disparities in household energy use pattern between rural and urban areas.

It will test the null hypothesis that no such disparities exist vis-a-vis the alternative hypothesis that there exists disparity in household energy use between rural and urban areas.

Database and Methodology

India has a population of 1,211 million as per census 2011 having sex ratio of 90 female per 1000 males. Literacy rate of female in India is 65.5 per cent and male is 82.1 per cent. The study is based on secondary data from Census 2001 and 2011, TERI 2013 and 2014, MOSPI, NSSO 2013 and 2014. The study has used simple statistical tools like descriptive statistics. Percentage method was used to explore the rural-urban differences in household energy use.

II. THEORETICAL LINKAGES OF RURAL AND URBAN HOUSEHOLD ENERGY CONSUMPTION

A study on energy consumption in household sector of China discovered that biomass was the dominant fuel in rural areas comprising 80 per cent of the total energy used whereas coal was in urban areas with 44 per cent (Tonooka *et al*, 2003). The sources of energy used in the household sector differs as per the type of job and level of income of the households, accessibility of energy sources both in rural and urban households (Reddy, 2004). The study further revealed that LPG was the primary source of energy used in urban areas and biofuel in rural areas. The type of energy utilized in the urban household sector of China was identified as more cleaner and effective than that of utilized by the rural households (Cai and Jiang, 2008). The study further revealed that out of the total energy utilized in urban household sector for electrical equipment and entertainment was dominant than cooking in rural household sector. Use of commercial energy was more by the households of urban areas and energy used in the urban household sector was moving towards modern fuels than that of energy used by the rural household sector of India and China (Pachauri and Jiang, 2008). The main reason behind the conversion of energy source in rural and urban areas were accessibility and nearby availability of energy sources, income of the households and prices of various energy sources. Energy consumption pattern in both the rural and urban household sectors of Sri Lanka though changing towards modern energy use but the rate of change in urban areas were faster than rural areas (Rajmohan and Weerahewa, 2010). Biomass and coal were the primary source of energy used in Nigeria in the rural areas whereas charcoal and kerosene in the urban areas (Desalu *et al*, 2012). The study further identified wealth of the household had a positive relationship with clean energy and negative relationship with traditional sources of energy. An analysis of the effect of income and population on the type of energy used by the households found fossil fuel to be a major source of energy used in urban areas in comparison to both fossil fuel and biomass in rural areas of China (Chung-sheng *et al*, 2012). Use of electricity, kerosene and LPG were larger by the urban households compared to the rural households of Nigeria (Anyiro *et al*, 2013). A study on household energy consumption in Nigeria

discovered electricity, local gas, charcoal and kerosene were used for the purpose of cooking by the households of urban areas and firewood as the key energy source by the rural households for the same (Nwofe, 2013). Biomass was the dominant energy among other sources of energy used in rural areas while electricity in urban areas of China (He and Reiner, 2014). Biomass was the major source of energy used in China for cooking by the rural households where coal, natural gas and oil by the urban households (Zheng *et al*, 2014). Energy consumption pattern of rural areas not only differed from urban areas but also changed overtime Khan *et al*, 2015). The study further identified electricity following firewood were the main source of energy used in rural areas but in urban areas natural gas following electricity were the major energy resources out of the total energy utilized in Pakistan. Per capita annual domestic consumption of LPG was 2.3 GJ, electricity 0.9 GJ, and kerosene 0.2 GJ in urban areas compared to 1.98 GJ of LPG, 0.57 GJ of electricity, 0.76 GJ of fuel wood and 0.45 GJ of kerosene in semi-urban areas of Assam (Sarmah and Bhattacharya, 2015). Per capita rural households use of fuel wood was 10.10 GJ, kerosene 0.37 GJ and electricity 0.0029 per year. Use of LPG was 39 per cent, electricity 65 per cent and candle 56 per cent in urban areas of Kenya which were inaccessible to the households of rural areas (Johnson and Nyambane, 2016). Energy expenditure in rural areas of India was highest on fuel wood but in urban areas on LPG (Pandey, 2016). Rural households used grimy energy sources as compared to the clean energy by the urban households. Gas and electricity was the lowest source of energy used in rural areas while fuel wood and electricity in urban areas of Nigeria (Elijah *et al*, 2017). Biomass was discovered to be the dominant fuel used in China for the purpose of cooking by 60 per cent of households of rural areas which was below 5 per cent in urban areas (Hou *et al*, 2017). Use of LPG and charcoal was more among urban households of Northern Ghana for cooking than households of rural areas who mostly used wood for the same (Wiedinmyer *et al*, 2017). Coal, fuelwood, dung, candle and paraffin were used by 95 per cent of households of rural Lesotho for different purposes while households of urban Lesotho were using cleaner energy (Zhou and Simbini, 2017). Average per capita energy need in rural areas of China was 34 to 149 gigajoule (GJ) as compared to 34 to 211 GJ of urban areas (Chen *et al*, 2019).

III. DATA ANALYSIS

India is the second highest populated country in the world and holds seventh position in the world in term of land mass among different sectors of our country, the energy sector helps in the growth of rest of the sectors and powers the whole economy. Out of total energy consumption in India coal constitute 44.3 per cent, biomass 21.2 per cent, Natural gas 5.8 per cent, Petroleum and other liquids 25.9 per cent, nuclear 1.1 per

cent, hydroelectric 1.4per cent and other renewable 0.9per cent (Energy Policy in India, 2017).

Energy Use pattern in the Household Sector of India

Energy consumption in the household sector basically focuses on energy consumption for lighting and cooking. Energy consumption pattern of rural households varies from that of urban households. As per Census 2011, 55.3per cent of households of rural areas use electricity as the main source of energy for lighting as compared to 92.7per cent of urban households. Biomass was the key source of energy used for cooking by the rural households as 86.5per cent of households were using it followed by 12.1per cent of households using LPG/PNG. On the other hand, 65.8per cent of urban households use LPG/PNG as the dominant energy source for cooking followed by 7.5per cent of households using kerosene. Monthly energy use pattern in rural India per household is different from that of urban India. The rural and urban energy use pattern in India is analysed in detail in the table 1.

Table 1: Rural and urban household energy use pattern in India (Per month)

<i>Sources of energy used</i>	<i>Rural Quantity</i>	<i>Urban Quantity</i>	<i>Differences (Urban-Rural)</i>
Coke (kg)	69.78	60.7	-9.08
Firewood and chips (kg)	118.02	89.42	-28.6
Electricity (kwh)	60.35	124.62	64.27
Dung cake(unit)	-	-	NA
Kerosene - PDS (litre) and other sources (litre)	5.1	7.99	2.89
Matches (box)	8.38	6.35	-2.03
Coal (kg)	55.1	65.95	10.85
LPG (in kg)	8.69	12.37	3.68
Charcoal (kg)	21.35	17.29	-4.06
Candle (number)	6.46	5.77	-0.69
Gobar gas (kg)	-	-	NA
Petrol (litre)	5.26	11.2	5.94
Diesel (litre)	3.03	3.73	0.7
Other fuel (kg)	-	-	NA

Source: Ministry of Statistics and Programme Implementation(MOSPI) 2012, National Sample Survey Office(NSSO), The Energy and Resource Institute(TERI) 2013-14, kg - Kilogram, kWh - kilowatt-hour, PDS - Public distribution system

Table 1 shows differences in monthly energy use pattern in rural and urban areas as coke, firewood and chips, match boxes, charcoal and candle were the primary sources of energy used by the rural households whereas electricity, kerosene, coal, LPG, petrol and diesel are used by the urban households for various domestic purposes (Census 2011).

Household Energy Use Pattern for Lighting in India

Percentage of households in rural areas using electricity per month for the purpose of lighting increased to 55.3per cent in 2011 from 43.6per cent in 2001 but the same using kerosene decreased to 43.2per cent in 2011 from 55.6per cent in 2001(Census 2001, 2011). While percentage of urban households using electricity for the same purpose per month increased to 92.7per cent in 2011 from 87.6per cent and using kerosene decreased to 6.5per cent in 2011 from 11.6 in 2001 which is shown in the in the table 2.

Table 2: Rural and urban household energy use pattern for lighting per month (in percentage)

Column no. /Row no.	Energy Sources	Percentage of households using energy for lighting					
		Rural			Urban		
		Census 2001	Census 2011	Decadal Percentage Change	Census of India 2001	Census of India 2011	Decadal Percentage Change
1	2	3	4	5	6	7	8
1	Electricity	43.6	55.3	0.26834862	87.6	92.7	0.05821918
2	Kerosene	55.6	43.2	-0.22302158	11.6	6.5	-0.43965517
3	Any other	0.3	0.5	0.66666667	0.2	0.3	0.5
4	No lighting	0.3	0.5	0.66666667	0.4	0.3	-0.25

Source: Census of India 2011, TERI 2013-14

The main source of energy used in the rural household sector changed from kerosene to electricity during the period 2001-2011(Census 2001 and 2011) as evident from table 2,while electricity continues to be the primary source of energy used by the urban households during the same period.

Household Energy Use Pattern for Cooking in India

As per 2011 census the key energy source used by the rural households for the purpose of cooking is biomass whereas it is LPG/LNG in the urban areas as shown in the table 3.

Table 3: Rural and urban household energy use pattern for cooking per month (in percentage)

Column no./ Energy Sources Row no.		Percentage of households using energy for cooking					
		Rural			Urban		
		Census 2001	Census 2011	Decadal Percentage Change	Census of India 2001	Census of India 2011	Decadal Percentage Change
1	2	3	4	5	6	7	8
1	Biomass	91	86.9	-0.04505	31.4	26.2	-0.16561
2	Kerosene	1.6	0.7	-0.5625	19.2	7.5	-0.60938
3	LPG/PNG	5.7	11.4	1	48	65	0.354167
4	Any other	1.4	0.8	-0.21429	1.1	0.9	-0.11111

Source: Census of India 2011, TERI 2013-14

Table 3 reveals that biomass is the dominant source of energy used for cooking in rural areas during the decade 2001-2011 even though there is a marginal reduction in its use. Use of kerosene also declined but use of LPG/LNG for cooking registers an increase in rural areas. Whereas LPG/PNG is the main source of energy used for cooking in urban areas during 2001-2011, the use of biomass and kerosene for the purpose decline.

Table 4: Percentage of households using energy for lighting in India (State wise)

Column no./ Row no.	India/State/ Union territory	Elect- ricity	India/State/ Union territory	Kero- sene	India/State/ Union territory	No lighting
1	2	3	4	5	6	7
1	India	67.3	India	31.4	India	0.5
2	Lakshadweep	99.7	Bihar	82.4	Arunachal Pradesh	10.5
3	Daman and Diu	99.1	Uttar Pradesh	61.9	Jammu and Kashmir	2.0
4	Delhi	99.1	Assam	61.8	Nagaland	1.1
5	Chandigarh	98.4	Odisha	55.3	Odisha	1.1
6	Puducherry	97.7	Jharkhand	53.1	Gujarat	1.0
7	Bihar	16.4	Lakshadweep	0.2	Lakshadweep	0.0
8	Uttar Pradesh	36.8	NCT of Delhi	0.7	Daman & Diu	0.1
9	Assam	37.1	Daman & Diu	0.8	Delhi	0.1
10	Odisha	43.0	Chandigarh	1.2	Chandigarh	0.2
11	Jharkhand	45.8	Puducherry	2.1	Puducherry	0.2

Source: Census of India 2011, TERI 2013-14

State Wise Rural and Urban Household Energy Consumption for Lighting in India

Rural urban disparities in household energy consumption for lighting are not only observed in India at the national level, but also within different states of India. Table 4 shows the differences in household energy consumption for lighting of rural and urban areas in different states of India.

Table 4 shows electricity is the key source of energy used for lighting in India as used by 67.3per cent of household followed by 31.4per cent of households using kerosene (Census 2011). Lakshadweep, Puducherry, Daman and Diu, Delhi and Chandigarh are the states where highest percentage of households are using electricity for lighting with 99.7per cent, 99.1per cent, 99.1per cent, 98.4per cent and 97.7per cent respectively among other states of India. Bihar, Uttar Pradesh, Assam, Odisha and Jharkhand are the least electricity user states with 16.4per cent, 36.8per cent, 37.1per cent, 43.0per cent and 45.8per cent respectively.

Bihar, Uttar Pradesh, Assam, Odisha and Jharkhand are the states where highest percentage of households were using kerosene with 82.4per cent, 61.9per cent, 61.8per cent, 55.3per cent and 53.1per cent respectively. Whereas Lakshadweep, NCT of Delhi, Daman and Diu, Chandigarh and Puducherry are the least kerosene user states with 0.2per cent, 0.7per cent, 0.8per cent, 1.2per cent and 2.1per cent of households using kerosene for lighting.

Table 4 also revealed that 0.5per cent households of India lives without lighting as per census 2011. States like Arunachal Pradesh where 10.5per cent, Jammu and Kashmir where 2.0per cent, Nagaland where 1.1per cent, Odisha where 1.1per cent and Gujarat where 1.0per cent of households have no lighting which is highest among other states of India. Whereas Lakshadweep with 0.0per cent, Daman and Diu with 0.1per cent, Delhi with 0.1per cent, Chandigarh with 0.2per cent and Puducherry with 0.2per cent of households are the states where lowest percentage of households have no lighting.

State Wise Household Energy Use Pattern of Lighting in Rural and Urban India

Pattern of rural household energy use for lighting varies from that of urban households within different states of India. Table 5 shows state wise decadal change in the energy use pattern in rural areas for lighting.

Table 5 shows an increase in use of electricity among various rural states of India for the purpose of lighting during the period 2001-2011(Census 2001, 2011) except Madhya Pradesh and Chandigarh. West Bengal, Tripura, Odisha, Assam and Meghalaya

Table 5: Decadal Percentage change in rural household energy use for lighting in India (State wise)

Column no./ Row no.	India/ State/ Union territory	Elect- ricity	India/ State/ Union territory	Kero- sene	India/ State/ Union territory	No lighting
1	2	3	4	5	6	7
1	India	0.271	India	-0.223	India	0.66
2	West Bengal	0.985	Lakshadweep	1	Odisha	1.75
3	Tripura	0.871	Chandigarh	0.142	Maharashtra	1.166
4	Odisha	0.835	Madhya Pradesh	0.099	Assam	1
5	Assam	0.721	Andaman and Nicobar Islands	-0.959	Andhra Pradesh	0.66
6	Meghalaya	0.702	NCT of Delhi	-0.892	Karnataka	0.66
7	Lakshadweep	0.001	Puducherry	-0.806	NCT of Delhi	-0.66
8	Daman & Diu	0.008	Andhra Pradesh	-0.768	Nagaland	-0.531
9	Himachal Pradesh	0.022	Tamil Nadu	-0.705	Dadra & Nagar Haveli	-0.5
10	Madhya Pradesh	-0.064	Uttar Pradesh	-0.056	Daman & Diu	-0.5
11	Chandigarh	-0.001	Assam	-0.154	Dadra & Nagar Haveli	-0.4

Source: Census of India 2011, TERI 2013-14

are the states where the decadal change of rural electricity use is more than other states with an increase by 0.98per cent, 0.87per cent, 0.83per cent, 0.72per cent and 0.70per cent respectively. Use of kerosene for lighting, declined during the period 2001-2011 among all the rural areas of different states of India excluding Lakshadweep where it increased by 1per cent. Chandigarh with a decline by 0.14per cent and Madhya Pradesh with 0.099per cent are the states where decadal reduction in the rural household kerosene use was more among other states of India.

Table 5 further reveals that there are some rural areas of different states of India who have no accessibility to lighting even during the period 2011-2011. Rajasthan, Uttar Pradesh and Uttarakhand are the states where there is no decadal change in the percentage of rural households who had no lighting. Chandigarh, Himachal Pradesh, Daman and Diu, Manipur, Mizoram, Chhattisgarh, Punjab were the states where decadal percentage change of rural households without lighting declined by 0.5per cent, 0.5per cent, 0.5per cent, 0.4per cent, 0.3per cent, 0.28per cent, 0.28per cent, 0.25per cent and 0.18per cent respectively, whereas in other states of India decadal percentage change in rural households without lighting increased during the year 2001-2011. State wise decadal change in the urban household energy use for lighting in India is shown in the table 6.

Table 6: Decadal percentage change in urban household energy use pattern (State wise) for lighting per month

Column no./ Row no.	India/ State/ Union territory	Elect- ricity	India/ State/ Union territory	Kero- sene	India/ State/ Union territory	No lighting
1	2	3	4	5	6	7
1	India	0.06	India	-0.44	India	-0.25
2	Jharkhand	1.16	NCT of Delhi	-0.89	Jammu and Kashmir	1
3	Kerala	1.15	Puducherry	-0.84	West Bengal	1
4	Assam	0.13	Kerala	-0.81	Manipur	0.67
5	Chhattisgarh	0.13	Andhra Pradesh	-0.78	Assam	0.5
6	Bihar	0.12	Nagaland	-0.75	Maharashtra	0.33
7	Jammu and Kashmir	0.00	Madhya Pradesh	-0.07	Daman & Diu	-0.67
8	Madhya Pradesh	0.00	Uttar Pradesh	-0.11	Nagaland	-0.78
9	Himachal Pradesh	0.01	Bihar	-0.19	NCT of Delhi	-0.5
10	Uttar Pradesh	0.02	Jammu and Kashmir	-0.25	Mizoram	-0.5
11	Maharashtra	0.02	Lakshadweep	-0.33	Meghalaya	-0.4

Source: Census of India 2001 and 2011

Table 6 shows decadal increase in the use of electricity for lighting in urban areas of different state of India during 2001-2011. There are some states like Jharkhand with an increase by 0.16per cent, Kerala with 0.15per cent, Chhattisgarh with 0.13per cent, Assam with 0.13per cent, Bihar with 0.12per cent, where the decadal percentage change in electricity use for lighting is higher than other states. Contrast to this Himachal Pradesh with 0.01, both Uttar Pradesh and Maharashtra with 0.02 percentage of households using electricity are the least electricity used states among other states of India during the decade.

Table 6 further reveals a decadal reduction in the percentage of urban households using kerosene for lighting in all the states of India. Delhi, Puducherry, Andhra Pradesh, Nagaland, Tamil Nadu are the states where decadal reduction in the percentage use of kerosene is more with 0.89per cent, 0.84per cent, 0.78per cent and 0.75per cent respectively, as compared to other states. Percentage of urban households without lighting declined in most of the states excluding Jammu and Kashmir, West Bengal, Manipur, Assam and Maharashtra where it increased by 1per cent, 1per cent, 0.66per cent, 0.5per cent and 0.66per cent respectively during the decade 2001-2011 as evident from table 6. The decline in percentage of households without lighting is highest in States like Daman and Diu with 0.67per cent, Nagaland 0.78per cent, NCT of Delhi 0.5per cent, Mizoram 0.5per cent and Meghalaya 0.4per cent among different states of India.

State Wise Rural and Urban Household Energy Use for Cooking in India

Primary source of household energy consumption for cooking in India varies among different states of India which is shown in the table 7.

Table 7: Household energy use pattern (State wise) for cooking per month (in percentage)

Column no./Row no.	India/ State/ Union territory	Bio-mass	India/ State/ Union territory	Kerosene	India/ State/ Union territory	LPG/ PNG	India/ State/ Union territory	Electricity
1	2	3	4	5	6	7	8	9
1	India	67.4	India	2.9	India	28.6	India	0.1
2	Bihar	89.9	Daman &Diu	30.8	NCT of Delhi	89.9	Meghalaya	1.6
3	Chhattisgarh	87.7	Chandigarh	21.9	Goa	72.7	Lakshadweep	1.2
4	Jharkhand	86.9	Dadra & Nagar Haveli	17.8	Chandigarh	71.6	Jammu and Kashmir	0.4
5	Odisha	86.2	Lakshadweep	13.7	Puducherry	70.5	Sikkim	0.3
6	Meghalaya	82.5	Puducherry	10.3	Punjab	54.5	Odisha	0.4
7	NCT of Delhi	4.4	Jharkhand	0.2	Bihar	8.1	Sikkim	0.3
8	Puducherry	4.4	Manipur	0.2	Odisha	9.8	Andhra Pradesh	0.1
9	Chandigarh	5.2	Kerala	0.4	Chhattisgarh	11.2	Arunachal Pradesh	0.1
10	Lakshadweep	5.2	Nagaland	0.6	Jharkhand	11.7	Chhattisgarh	0.1
11	Daman & Diu	12.7	Tripura	0.6	Meghalaya	11.9	Goa	0.1

Source: Census of India 2011, TERI 2013-14

Table 7 reveals that biomass is the dominant source of energy used for cooking in India and is used by 67per cent of households, whereas kerosene is used by 2.9per cent of households and LPG/PNG is used by 28.6per cent of households. Bihar is the highest user state of biomass with 89.9per cent of households using it followed by Chhattisgarh with 87.7per cent, Jharkhand with 86.9per cent, Odisha with 86.2per cent, Meghalaya with 82.5per cent of the households (Census 2011). On the other hand, Puducherry, Delhi, Lakshadweep, Daman and Diu are the least user states of biomass with 4.4per cent, 4.4per cent, 5.2per cent and 12.7per cent of households using it respectively.

Among the states where we find a higher use of Kerosene for cooking, Daman and Diu (with 30.8per cent of households), Chandigarh (with 21.9per cent), Dadra and Nagar Haveli (with 17.8per cent), Lakshadweep (with 13.7per cent) and Puducherry (with 10.3per cent of households) are on the top of the list. And Jharkhand, Manipur, Kerala, Nagaland and Tripura are the least kerosene user states with 0.2per cent, 0.2per

cent, 0.4per cent, 0.6per cent and 0.6per cent of households using kerosene for cooking respectively.

NCT of Delhi with 89.9per cent of the households, Goa with 72.7per cent, Chandigarh with 71.6per cent, Puducherry with 70.5per cent and Punjab with 54.5per cent of households using LPG/PNG are the highest LPG/PNG user states among the states of India. At the bottom of the table we find Bihar with 8.1per cent, Odisha with 9.8per cent, Chattisgarh with 11.2per cent, Jharkhand with 11.7per cent and Meghalaya with 11.9per cent households are the lowest LPG/PNG user states as in these states biomass is the primary source of energy used for cooking. State wise decadal change in the rural household energy use for cooking in India is shown in the table 8.

Table 8: Decadal percentage change in the rural household energy use for Cooking in India (State wise)

Column no./ Row no.	India/ State/ Union territory	Bio-mass	India/ State/ Union territory	Kero-sene	India/ State/ Union territory	LPG/ PNG	India/ State/ Union territory	Elect-ricity
1	2	3	4	5	6	7	8	9
1	India	-0.06	India	-0.56	India	1	India	0
2	Daman & Diu	0.81	Lakshadweep	0.97	Bihar	3.25	Lakshadweep	16
3	Chandigarh	0.26	Puducherry	0.10	Puducherry	2.14	Arunachal Pradesh	-0.75
4	West Bengal	0.02	Chhattisgarh	-0.83	Odisha	2.1	Odisha	-0.67
5	Dadra & Nagar Haveli	0.00	Rajasthan	-0.83	Andaman and Nicobar Islands	2.056	Himachal Pradesh	-0.5
6	Tripura	0.00	Manipur	-0.81	Uttar Pradesh	1.46	Jharkhand	-0.5
7	Madhya Pradesh	-0.00	Madhya Pradesh	-0.77	Dadra & Nagar Haveli	0.11	Bihar	0
8	Jharkhand	-0.01	Andaman and Nicobar Islands	-0.21	Kerala	0.11	Jammu and Kashmir	0
9	Meghalaya	-0.01	Karnataka	-0.21	Daman & Diu	0.25	Maharashtra	0
10	Manipur	-0.01	Meghalaya	-0.46	NCT of Delhi	0.31	Manipur	0
11	Odisha	-0.01	Andhra Pradesh	-0.5	Uttarakhand	0.38	Meghalaya	0

Source: Census of India 2011, TERI 2013-14

Table 8 shows a decadal reduction in the percentage of households using biomass by 0.06per cent and kerosene by 0.56per cent at the national level, but an increase in the percentage of households using LPG/PNG by 1per cent and no change in the percentage of household using electricity for cooking in India during the period 2001-2011. Daman and Diu (with an increase of 0.81per cent), Chandigarh (with 0.26per cent) and West Bengal (with 0.02per cent) are the states where the percentage of

households which are using biomass showed an increase during the decade of 2001 to 2011. Dadra and Nagar Haveli and Tripura are the states where there is no decadal change in the percentage of households using biomass for cooking. On the other hand, Madhya Pradesh, Jharkhand, Meghalaya, Manipur and Odisha are the states where there is a decadal reduction in the use of biomass by the households to the extent of 0.01 per cent.

The table 8 further reveals a reduction in the use of kerosene during the period 2001-2011 except in Lakshadweep and Puducherry. Contrary to this, use of LPG/LNG for cooking increased during the year 2001-2011 in the rural areas of different states of India. It is evident from table 8 that biomass is the dominant energy source used in rural areas. The table 8 also shows reduction in the use of kerosene. This implies that households of rural areas are shifting from traditional to modern source for the purpose of cooking, biomass still being the primary source of energy use. State wise decadal change in the urban household energy use for cooking in India is shown in the table 9.

Table 9: Decadal percentage change in urban household energy use pattern (State wise) for cooking per month

Column no./Row no.	India/ State/ Union territory	Bio-mass	India/ State/ Union territory	Kero-sene	India/ State/ Union territory	LPG/ PNG	India/ State/ Union territory	Elect-ricity
1	2	3	4	5	6	7	8	9
1	India	-0.18	India	-0.61	India	0.35	India	-0.33
2	Gujarat	1.11	Daman & Diu	1.71	Andaman and Nicobar Islands	0.63	Lakshadweep	10
3	Sikkim	0.42	Lakshadweep	0.23	Nagaland	0.54	Himachal Pradesh	0.25
4	Chandigarh	0.28	Gujarat	0.11	Puducherry	0.51	Meghalaya	0.18
5	Tripura	0.10	Bihar	-0.88	Jharkhand	0.50	Goa	-1
6	Himachal Pradesh	0.06	Jammu and Kashmir	-0.82	Bihar	0.48	Maharashtra	-1
7	Mizoram	-0.46	Arunachal Pradesh	-0.82	Odisha	0.47	Rajasthan	-1
8	Arunachal Pradesh	-0.35	Chandigarh	-0.25	Karnataka	0.46	Tripura	-1
9	Andhra Pradesh	-0.35	Meghalaya	-0.29	Lakshadweep	-0.23	Andhra Pradesh	0
10	Jammu and Kashmir	-0.05	Dadra & Nagar Haveli	-0.35	Daman and Diu	-0.30	Arunachal Pradesh	0
11	Madhya Pradesh	-0.09	Puducherry	-0.44	Chhattisgarh	-0.95	Manipur	0

Source: Census of India 2001 and 2011, TERI 2013-14

Table 9 shows a decadal reduction in percentage of household using biomass, kerosene and electricity for cooking in India by 0.18per cent, 0.61per cent and 0.33per cent respectively whereas an increase is observed in the use of LPG/PNG by 0.35per cent in urban areas during the period 2001-2011. Percentage of urban households using biomass for cooking in most of the states decreased except in Gujarat, Sikkim, Chandigarh, Maharashtra, Chandigarh and Tripura where it increased by 1.11per cent, 0.42per cent, 0.05per cent, 0.28per cent and 0.10per cent respectively. Mizoram, Arunachal Pradesh, Andhra Pradesh, Jammu and Kashmir and Madhya Pradesh are the states where this decadal reduction in the percentage of households using biomass is the lowest among the states of India with the reduction amounting to 0.46per cent, 0.35per cent, 0.35per cent, 0.05per cent and 0.09per cent respectively.

Table 9 further reveals a decline in the use of kerosene in urban areas of different states except Daman and Diu, Lakshadweep and Gujarat where it increased by 1.17per cent, 0.23per cent and 0.11per cent respectively during the period 2001 - 2011. On the other hand use of LPG/PNG increased in almost all the urban areas except Daman and Diu and Lakshadweep for cooking as most of the households of these states are using kerosene for cooking as evident from table 9.

LPG/PNG was the main source of energy used in urban areas of India for the purpose of cooking as there is a decadal increase in the percentage of households using LPG/PNG in all the states except Lakshadweep, Daman and Diu and Chhattisgarh where it declined by 0.23per cent, 0.30per cent and 0.95per cent respectively. Andaman and Nicobar Islands, Nagaland, Puducherry, Jharkhand, Bihar, Odisha and Karnataka are the highest user states of LPG/PNG and the number of households in urban areas using it was 0.63per cent, 0.54per cent, 0.51per cent, 0.50per cent, 0.48per cent, 0.47per cent and 0.46per cent respectively.

Percentage of households using electricity declined in most of the states except Lakshadweep, Himachal Pradesh and Meghalaya where it increased by 10per cent, 0.25per cent and 0.18per cent respectively during the period 2001-2011. Andhra Pradesh, Arunachal Pradesh and Manipur are the states where there is no decadal change in the percentage of households using electricity for cooking.

It is therefore evident that rural and urban disparity exists in energy used for cooking as biomass is the dominant energy used for cooking in rural areas contrary to LPG/PNG being the primary source of energy used in urban areas.

IV. CONCLUSION

The study analysed the household energy use pattern of India for lighting and cooking and found existence of disparities between rural and urban energy use pattern. Electricity

is the major source of energy which is used in both rural and urban areas for the purpose of lighting. But for the purpose of cooking biomass is the primary source of energy used in the rural areas as against LPG/PNG in the urban areas.

While analysing the decadal change in the rural and urban household energy use during the period 2001 to 2011, the study found that the households were shifting from kerosene to electricity and biomass to LPG/PNG for lighting and cooking purposes in urban and rural areas respectively despite biomass being the dominant source of energy used for cooking in rural areas. This shifting of households from traditional form to modern form of energy use for various household purposes is the effect of urbanization or modernization where everybody wants to have a comfortable living. It further results in raising the demand for safe and clean energy which has no adverse impact on environment.

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References

- Alam, M., Sathaye, J. and Barnes, D. (1998). Urban Household Energy Use in India: Efficiency and Policy Implications. *Energy Policy*, 26(11), 88-891. [https://doi.org/10.1016/S0301-4215\(98\)00008-1](https://doi.org/10.1016/S0301-4215(98)00008-1).
- Anyiro, CO., Ezech, CI., Osondu, CK. and Nduka, GA.(2013). Economic Analysis of Household Energy Use: A Rural Urban Study of Abia State, Nigeria. *Research and Reviews: Journal of Agriculture and Allied Sciences*, 2(2), 20-27. <https://www.rroj.com/open-access/economic-analysis-of-household-energy-use-a-rural-urban-case-study-of-abia-state-nigeria.php?aid=33974>.
- Barnes, DF. and Floor, WM.(1996). Rural Energy in Developing Countries: A Challenge for Economic Developments. *Annual Review of Energy and the Environment*, 21, 497-530. <https://doi.org/10.1146/annurev.energy.21.1.497>.
- Cai, J. and Jhiang, Z.(2007). Changing of Energy Consumption Pattern from Rural to Urban Households in China: An Example from Shaanxi Province, China. *Renewable and Sustainable Energy Reviews*, 2(6), 1667-1680. <https://doi.org/10.1016/j.rser.2007.03.002>.
- Census 2011, Office of the Registrar General and Census Commissioner, India, Ministry of Home affairs, Government of India. <https://censusindia.gov.in/>.
- Chen, G., Zhu, Y., Wiedmann, T., Yao, L., Xu, L. and Wang, Y.(2019). Urban-rural Disparities of Household Energy Requirements and Influence Factors in China: Classification Tree Models. *Applied Energy*, 250(C), 1321-1335. <https://doi.org/10.1016/j.apenergy.2019.04.170>.
- Chun-sheng, Z., Shu-wen, N. and Xin, Z. (2012). Effects of Household Energy Consumption on Environment and its Influence Factors in Rural and Urban Areas. *Energy Procedia*, 14, 805-811. <https://doi.org/10.1016/j.egypro.2011.12.1015>.

- Desalu, OO., Ojo, OO., Ariyibi, EK., Kolawole, TF. and Ogunleye, AI. (2012). A Community Survey of the Pattern and Determinants of Household Sources of Energy for Cooking in Rural and Urban South Western, Nigeria. *Pan African Medical Journal* 2012;12:1-12. <https://ncbi.nlm.nih.gov/pmc/articles/PMC3396866/>.
- Elijah, OA., Balikis, LI. and Ambali, OI. (2017). Comparative Analysis of Access and Preferences of Rural and Urban Households for Cooking Energy and the Determinants in Nigeria: A Case of Ogun State. *Agricultural Tropica et Subtropica*, 50(1), 45-53. <https://doi.org/10.1515/ats.2017.0006>.
- Energy Statistics (2019). Central Statistical Office, Ministry of Statistics and Programme Implementation, Govt. of India. <http://mospi.nic.in/publication/energy-statistics-2019>.
- Farsi, M., Filipini M. and Pachauri, S.(2007). Fuel Choices in Urban Indian Households. *Environment and Development Economics*, 12(6), 757-774. <https://doi.org/10.1017/S1355770X07003932>.
- He, X. and Reiner, D. (2017). Electricity Demand and Basic Needs: Empirical Evidence from China's Households. EPRG Working Paper 1416, Cambridge Working Paper in Economics accessed on 16.09.2017 at 8:00p.m.. www.eprggroup.com.ac.uk/.
- Hou, BD., Tang, X., Ma, C., Liu, L., Wei, YM. and Liao, H. (2017) Cooking Fuel Choice in Rural China: Results from Micro data. *Journal of Cleaner Production*, 142(2), 538-547. <https://doi.org/10.1016/j.jclepro.2016.05.031>.
- Johnson, O. and Nyambane, A. County Energy Planning in Kenya: Local Participation and Local Solutions in Migori County. Stockholm Environment Institute, Working Paper 2016-01. <https://sei.org/documents/Publications/SEI-WP-2016-01-Kenya-county-energy-planning.pdf>.
- Khan, AH., Khalid, U. and Shahnaz, L. Energy Demand Elasticity in Pakistan: An Inter-temporal Analysis from Household Survey Data of PIHS 2001-02 and PSLM 2010-11. Working Paper, National University of Sciences and Technology, Pakistan. <http://ihsn.org/index.php/citations/77358>.
- Ministry of Statistics and Programme Implementation(MOSPI) 2012. <http://mospi.nic.in/statistical-year-book-india/2012/>.
- National Sample Survey Office (NSSO) 2011-12. <https://catalog.ihsn.org/index.php/catalog/3281>.
- Nwofe, P.(2013). Comparative Analysis of Domestic Energy Use in Nigeria - A Review. *Continental J. Renewable Energy*, 4(1), 7-17. <http://doi.org/10.5707/cjre.2013.4.1.7.17>.
- Pachauri, S. and Jiang, L.(2008). The Household Energy Transition in India and China. *Energy Policy* 36(11), 4022-4035. <https://doi.org/10.1016/j.enpol.2008.06.016>.
- Pandey, A.K.(2016). Measuring Energy Intensity and Electricity in India: A Dummy Variable Approach for Unit Level Household Data. *Jindal Journal of Business Research*, 3(1-2) 77-92. <https://doi.org/10.1177/2278682116647602>.
- Rajmohan, K. and Weerahewa, J. (2010). Household Energy Consumption Patterns in Sri Lanka. *Sri Lankan Journal of Agricultural Economics*, 9, 55-77. <http://doi.org/10.4038/sjae.v9i0.1833>.
- Reddy, BS. (2004). Economic and Social Dimensions of Household Energy Use: A Case Study Of India. Proceedings of IV Biennial International Workshop "Advances in Energy Studies", Unicamp, Campinas, SP, Brazil, June 16-19, 2004, 469-477. <https://1library.net/document/yer4300q-economic-social-dimensions-household-energy-case-study-india.html>.
- Sarmah, R. and Bhattacharya, D. (2015). A Study on Domestic Energy Consumption in Rural, Semi-urban and Urban Sectors of Jorhat District: Assam. *International Journal of Engineering Trends and Technology*, 30(8), 389-392. <http://doi.org/10.14445/22315381/IJETT-V30P273>.

- Socio-Economic and Cast Census 2011. <https://secc.gov.in>
- TERI Energy and Environment Data Directory and Year Book 2013/14. <https://bookstore.teri.res.in/books/9788179935446>
- The Energy and Resource Institute(TERI) 2013-14. <https://bookstore.teri.res.in/books/9788179935446>
- Tonooka, Y., Mu H., Ning, Y and Kondo, Y.(2003). Energy Consumption in Residential House and Emissions Inventory of GHGs, Air Pollutants in China. *Journal of Asian Architecture and Building Engineering*, 2(1), 93-100. <https://doi.org/10.3130/jaabe.2.93>.
- Wiedinmyer, C.(2017). Rural-Urban Differences in Cooking Practices and Exposures in Northern Ghana. *Environmental Research Letters*, 12(6), 1-9. <http://iop.org/article/10.1088/1748-9326/aa7036/pdf>.
- World Economic Outlook October 2018. <https://www.imf.org/en/Publications/WEO/Issues/2018/09/24/world-economic-outlook-october-2018>.
- Zheng, X. *et al* (2014). Characteristics of Residential Energy Consumption in China: Findings from a Household Survey. *Energy Policy* 2014, 75, 26-135. <http://doi.org/10.1016/j.enpol.2014.07.016>.
- Zhou, PP. and Simbini, T. Rapid Assessment and Gap Analysis for Lesotho. Sustainable Energy for all, UNDP Working Paper, accessed on 22.09.2017 at 9:45 a.m., www.se4all.org/sites/default/files/Lesotho_RAGA_EN_Release.pdf.
- <http://bookstore.teri.res.in/docs/books/TEDDY14/domestic/domestic.pdf>.
- <http://en.wikipedia.org/>
- http://en.wikipedia.org/wiki/Energy_Policy_of_India
- <http://www.google.com/search?client=firefox-b-d&q=importance+of+energy+sector+over+other+sectors+of+india>
- <http://www.google.com/search?client=firefox-b-d&sxsr>
- <http://www.yourarticlelibrary.com/essay-on-energy-importance-and-sources/42595>
- <http://www.mospi.gov.in>